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ARMY ORDNANCE

VOL. VIII MARCH-APRIL, 1928 No. 47

THE NEW MEDIUM TANK DEVELOPED BY THE ORDNANCE DEPARTMENT, U. S. A.

AMERICA IN THE WORLD WAR
Newton D. Baker
Secretary of War during the World War

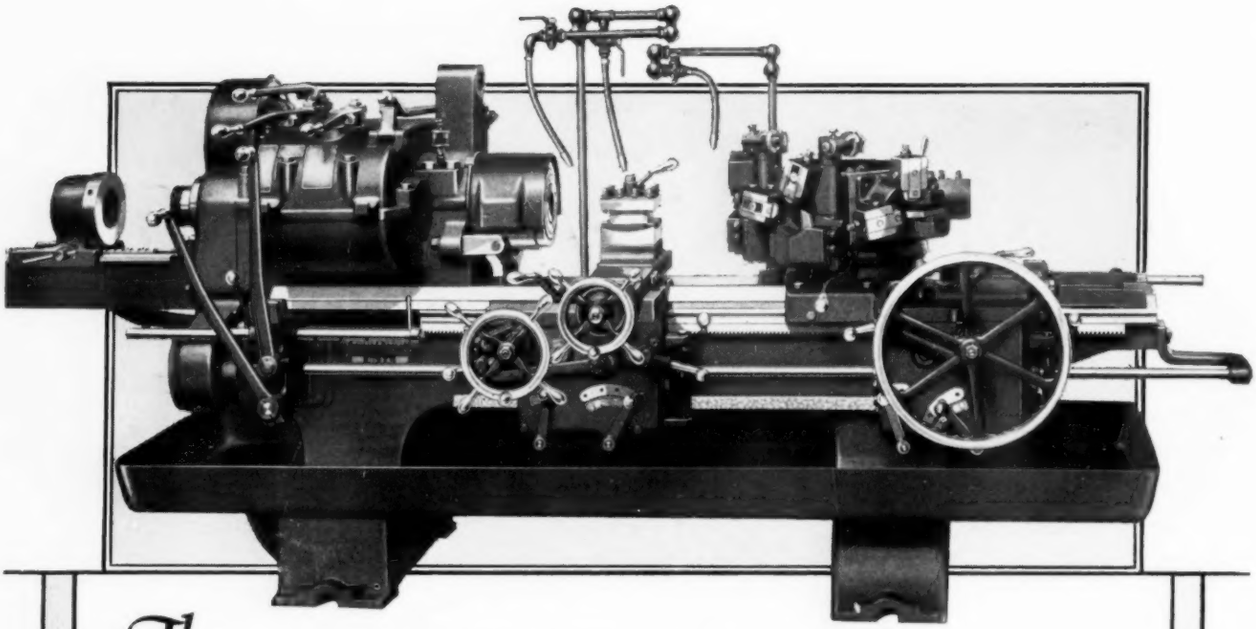
1927 ORDNANCE
Maj. Gen. C. C. Williams, U. S. A.
Chief of Ordnance

TRACER AMMUNITION
Capt. S. P. Meek, Ord. Dept., U. S. A.

ANTIFRICIION BEARINGS IN ORDNANCE WORK
F. Brauer

THE GAGE LABORATORY AT WATERVLIET ARSENAL
L. W. Dwyer

AOA
THE JOURNAL OF THE ARMY ORDNANCE ASSOCIATION



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ARMY ORDNANCE

The Journal of the Army Ordnance Association

Pledged to Public Service in Effecting Industrial Preparedness for War as Our Strongest Guarantee of Peace

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"The increasing interest all over the nation in industrial preparedness is a frank declaration to the world that we not only want peace but that we intend to have it."

HANFORD MACNIDER, *Former Assistant Secretary of War.*

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THE Army Ordnance Association is a national organization of American citizens pledged to industrial preparedness for war as our nation's strongest guarantee of peace.

THE Association endeavors to keep alive an interest in and knowledge of the design, production and maintenance of munitions. Other than a few manufacturing arsenals—six in all—there is no peace-time industry for the production of ordnance. Should war unhappily come again, industrial America will be called upon to produce munitions in great quantity and of intricate and unusual design. In an emergency time will not permit careful study or long preparation for the production of munitions. The problem is one of vital concern.

THE Army Ordnance Association believes that the solution of this problem, based on experience, lies in an active organization at all times cooperating with the Government. The principal objective of the Association is an active membership of American citizens, on whom the duty of design and production of munitions will fall in war, who will have an accurate and authentic knowledge of the complex requirements of ordnance. "Peace Insurance" in this form is the foremost aim of the Army Ordnance Association.

THE Association is purely patriotic; it has no commercial interests, no political alliances, and no religious affiliations. It is not operated for profit: its income is expended in furthering its aims. Its officers and directors serve without remuneration.

ARMY ORDNANCE, the journal of the Association, is published solely for the purpose of disseminating information on the progress of our munitions developments so that American industry may at all times know its responsibilities to the common defense.

The objectives of the Association as set forth in its Constitution are:

To assist in effecting industrial preparedness for war as being one of the nation's strongest guarantees of peace;

To keep available the highly specialized knowledge necessary for arming the manhood of the nation by stimulating interest in the design and production of ordnance material;

To promote mutual understanding and to effect cooperation with American Scientists, Inventors, Engineers and Manufacturers in civil life and the Regular and Reserve Officers of the Army Ordnance Department;

To provide, when required, the services of competent committees to investigate and report upon special ordnance subjects;

To assist in developing and maintaining an efficient personnel, both commissioned and enlisted, for the units required for Ordnance Field Service in the event of an emergency;

To commemorate the services rendered by the Industry of the Nation and by the Officers and Civilian Employees of the Ordnance Department in the wars in which the United States has been engaged.

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Signal Corps Photo.

While the War-to-End-War Raged

Two aged Frenchmen receiving aid from American and Australian soldiers. Busigny, Nord, France. October, 1918.

ARMY ORDNANCE

VOL. VIII MARCH-APRIL, 1928 No. 47

America in the World War

By Newton D. Baker*

CAPTAIN FROTHINGHAM, believing that certain views expressed to him in personal conversation and certain events and facts related to him would be of general interest in connection with this volume,** has invited me to state them in a prefatory note. What follows, therefore, is in no sense an introduction to the book, which tells its own story, but is rather a response to an invitation to state the facts about two or three of the larger aspects of our organization for war as they appeared to me as Secretary of War at the time.

Capt. Thomas G. Frothingham
Author of The American Reinforcement in the World War

Ten years have gone by since the United States entered the World War, and, in this tenth anniversary year of 1927, it is possible to obtain the right perspective. Captain Frothingham's book is a serious effort to describe in their true relative proportions the great forces, industrial, military, and naval, which brought into being and sustained the American Army on the Western Front. The book also aims to show the use of this American military reinforcement, in its relation to the armies of the Entente Allies on the battlefields of Europe. Apart from the skill and detachment of its author, the book has the advantage of being far enough away, in time, from events and persons to rest upon fuller evidence and calmer analysis than was possible to books written in the high tension months of the war itself or the several years of low tension which so soon followed the Armistice.

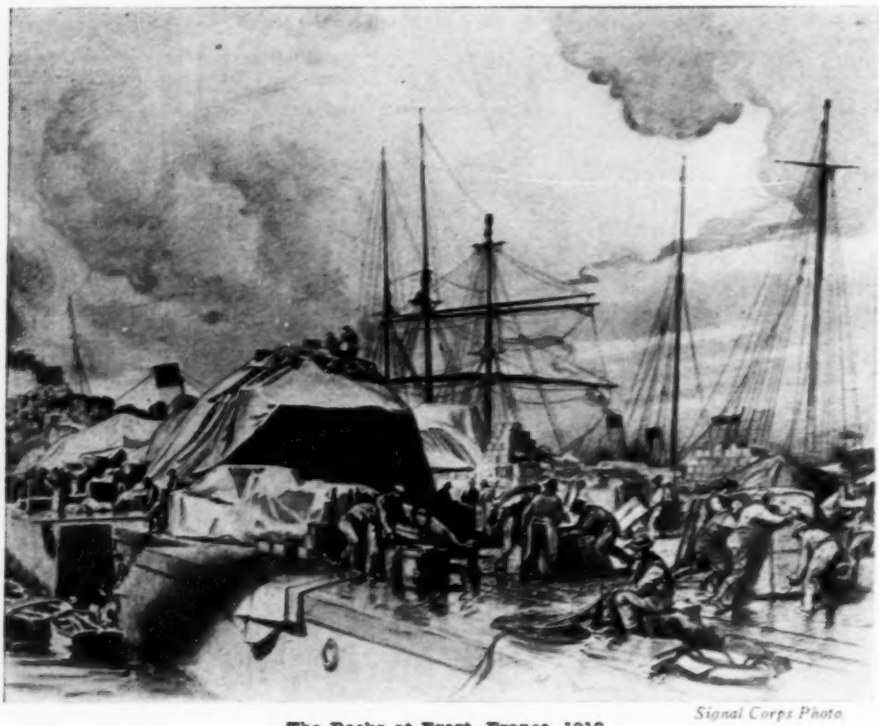
It is to be hoped that monographs will follow, giving the details of these many American activities, and personal narratives which will supplement this history of the American effort in the World War. Three personal military narratives, in particular, are still to appear. We are all eager to have them, the authoritative statements of the three American military leaders in their respective spheres of duty. General Pershing's own story will be necessary to satisfy the curiosity about his problems which is aroused by our grateful pride in his achievements. General Bliss, who represented us as military adviser to the Supreme War Council at Versailles, should tell us of the coördination of fronts and the coöperations of allies which finally succeeded against another coalition, in which the masterful dominance of the German General Staff imposed Germany's will upon her allies as autocratically as it sought to impose it upon her enemies. To complete the picture, we need General March's account of the battle on the home front—it was a battle—in which a stern and resolute soldier refused to concede either to tradition or to sentiment the least point which delayed or hindered his support of our forces overseas. When these stories are told, others will follow, filling in details and adding illustrative incidents and heroic episodes. It will be a help to the study of these volumes that Captain Frothingham's narrative carries us into broader thinking and gives us the basis for juster judgments than we have been able so far to form.

One of the characteristics of advancing civilization is the progressive amelioration of the effects of force; war completely reverses the process. This, of course, has nothing to do with the objects or justification of any particular war, for it may be temporary or necessary, in search of a higher good or in self-preservation. But while war lasts, force reigns, and laws, human and divine, are silent. The last war was, in a very literal sense, a world war. Not only did its consequences affect the entire political and economic structure of modern society, but it drafted men from the desert and supplies from the recesses of dark continents to feed the fires which burned at the same time on a dozen widely scattered fronts. It stripped the human race of its variant civilizations and subjected all men everywhere simultaneously to the dominance of a single primitive passion. Within each nation the war interrupted all customary and familiar relations. Each nation started with "business as usual" as a slogan for its civil population and ended with its civilians almost as militarized as its soldiers.

The fact is that war requires a continuous improvisation. From the battle of the Marne on, even Germany was obliged to improvise. German preparedness sufficed up to the first major unforseen obstacle, but after that Germany too had to dig in and take many fresh and different starts, with all the adaptations that that implies. To peoples democratically governed, so high a state of pre-war preparedness is unattainable. They can be prepared to parry, not to deliver, the first blow; thus

*Secretary of War, 1916-1921.

**The American Reinforcement in the World War. By Capt. Thomas G. Frothingham, U. S. R. Introduction by Newton D. Baker. Garden City, N. Y.: Doubleday, Page and Company. 1927. Mr. Baker's introduction is published in Army Ordnance through the courtesy of the authors and the publishers.



Signal Corps Photo

The Docks at Brest, France, 1918

Giving an idea of the accumulation of stores for the A. E. F. unloaded almost daily from ships arriving from America. (From the painting by Capt. A. Duncan.)

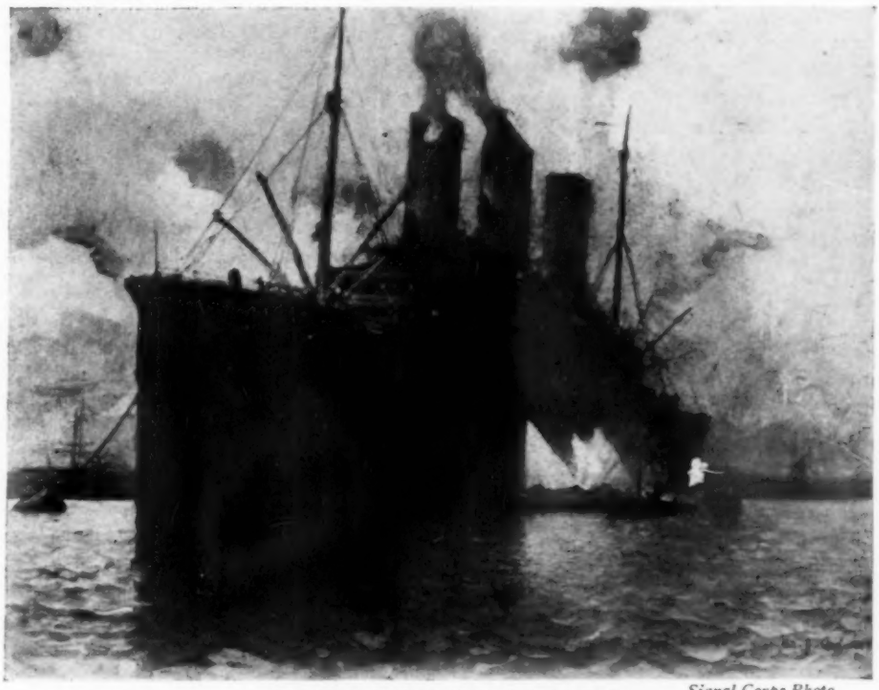
improvisation comes earlier with them and is more confused, less positive. It is also more disconcerting, coming, as it does, as a part of the greater shock of discovering any preparation at all to be necessary. So it was that, when Germany declared war, her armies marched with confident banners, while when we entered the conflict there was deep searching of hearts and hurried exploration of resources to find a basis upon which to build confidence.

I have, as a souvenir, one of the several million post cards mailed by the French War Office when mobilization was ordered. They were all addressed and in readiness and told each man in France his immediate duty. When we went into the war, nobody knew what anybody's duty was to be apart from the regular, organized forces of the country. Thus, for days and weeks after our entrance into the war, as the country comprehended and sympathized, there surged in upon Washington, by telegram, by letter, and in per-on, literally tens of thousands of men and women of all ages and occupations, filled with devoted and loyal zeal, wanting merely to be told where they could help, where their duty led. But Washington had, and in the nature of the case could have, only a few answers ready. Certain steps had been taken which gave us a start, and they were invaluable, but they were few and inadequate. The genius of Secretary Root had given the army a General Staff, in place of the wrangling bureau system in the War Department, but Congress had imposed limitations upon the personnel of the General Staff which kept it barely sufficient in numbers to preserve the semblance of centralized administration and quite inadequate to its more important task of visualizing and preparing for a great and sudden mobilization. The service schools, notably at Leavenworth and Fort Sill, had for some years been successfully transforming our officers from Indian fighters into modern soldiers, and the officers trained in those schools proved in the war the value of their post-graduate instruction—but they were a handful as compared with the vast officer personnel required for the armies which gathered into the cantonments and camps. The Plattsburg system of training camps for officers, established by Major General Leonard Wood, was an invaluable model upon which it was possible to build a great series of such camps. The officers so trained were indispensable. Both the mobile part of the Regular Army and the National Guard had been mobilized on the Mexican border for practically a year and had there gotten both the experience of being parts of large forces and those elementary initiations into hardships and coöperation which take time with young soldiers and make "an army of a million men between sunrise and sunset" an impossible exaggeration. The value of this preparation can hardly be overestimated, and its results were shown in the ease with which the new men acquired camp habits from the sprinkling of border men among them.

On the side of industrial mobilization we were singularly fortunate. In the years prior to the World War, the United States had developed a highly organized industrial system. The abundance and variety of our natural resources invited the ingenuity of our engineers, and they, adopting the results of the researches of our own scientists and of the advances of science elsewhere, rapidly developed the industrial arts. At the same time, our industrial progress was marked by changes and developments in business methods in the interest of economy and efficiency. By 1914 we had learned to do things on a vast scale. Standardizations of methods and product, mass production, and widespread and rapid distribution characterized our industry. Inevitably men of vision and power had come to preside over our great industrial establishments, and the whole country had caught the spirit of the industrial advance as a romantic adventure. To a greater extent than we or anybody else had realized, modern war is essentially an industrial art. Improved transportation facilities have rendered possible the collection and supplying of armies which would have starved under earlier conditions.

The demands of the modern fighting force for munitions are constant and all but insatiable. Perhaps the best illustration of this is that given by Colonel Leonard P. Ayres in his official summary on the war with Germany. Comparing the battle of the Wilderness in the Civil War with the battle of the Meuse-Argonne, he says: "The Meuse-Argonne lasted six times as long as the battle of

the Wilderness; twelve times as many American troops were engaged as were on the Union side; they used in the action ten times as many guns and fired about one hundred times as many rounds of artillery ammunition. The actual weight of the ammunition fired was greater than that used by the Union forces during the entire Civil War." This comparison, however, deals only with artillery ammunition. The equipment of a modern army contains all of the old arms, improved with intricate mechanical devices, and, in addition to them, complicated mechanisms like tanks, motor transport, and airplanes. For the production of these the highest industrial organization is necessary. The pilot in his airplane has taken the place of the cavalryman on horseback as the eye of the army. Thus the soldier in the field rests for his efficiency and his safety upon the mechanic at home, and war is conducted under modern conditions by the joint effort of the soldiers in the trench and the workmen in the factory separated by thousands of miles, but each indispensable to success.



The U. S. S. Leviathan on War Duty *Signal Corps Photo.*

The giant transport which carried thousands of American soldiers overseas is shown coaling at night in the harbor at Brest. (From the painting by Capt. A. J. Aylward.)

Prior to our entrance into the war, American industry had to some extent adapted itself to the production of war material, but in the vaster adaptation necessary to assure continuity of military supplies to the Allies and at the same time furnish and sustain our own great forces, the greatest masters of industry and business were necessary. The most immediate and pressing problem the War Department faced was to bring these men into complete and effective coöperation with our military men. My own life had been spent in an industrial city. I knew the spirit which animated American industry and the enthusiasm with which its leaders would coöperate in a national emergency. The legislative basis of such coöperation, however, was slight. Our national practice has always been to enact war-time legislation after war begins. The Act providing for the Council of National Defense was passed as a rider on the Army Appropriation Bill of 1916. Its donation of power, so far as the express language of the Act is concerned, was modest and tentative. As a matter of fact, the Council of National Defense was given no power, and the Advisory Committee was, from the point of view of the legislation, an academic and purely advisory body. Happily, however, a series of broad, if not bold, interpretations of the Act enabled us to set up an effective organization. The outstanding feature was the Advisory Committee, under the incisive and entirely practical leadership of Daniel Willard, which turned rapidly, as the possibility of our entrance into the war drew nearer from its early search for the best scheme of civilian and industrial organization to a series of recommendations to meet real and practical problems as they arose.

In this connection, a highly fortunate circumstance was the presence in Washington of Frank A. Scott. Mr. Scott, as president of a company manufacturing high-grade machine tools and certain instruments of precision for both the Army and the Navy, had been summoned to the War Department to help organize a board to standardize munitions and their manufacture. Thus coöperation between the Ordnance Department and civilian industrial agencies, which would be called upon for supplies in any emergency, was already established. Happily, Mr. Scott was a man of vision and resourcefulness and also a man of tact and sanity. Under his leadership, from the beginning, there were understanding, good will, and effective coöperation between the officers of the Army, Navy, and civilians. He saw approaching difficulties as they arose and brought them to me while they were small and easily overcome. He brought, too, thoughtful suggestions for the solution of industrial problems. The security and confidence with which I came to rely upon his judgment and foresight is a happy recollection of days very heavy with perplexities and responsibilities. Mr. Scott, Mr. Gifford of the Council of National Defense, General Palmer Pierce, and their associates laid the foundations of our industrial mobilization, both in the matter of organization and of policy, and the future organization and policies were but developments along the lines laid down by them: expansions which came with the experience of new and larger needs.

At the very outset, the Munitions Standards Board subdivided the field of its activities. Separate sections of it had charge of artillery, small arms, gages, and dies, and other military equipment. The Board was organized in March, 1917, just before we entered the war; it rapidly extended the scope of its own activities, and, in a few weeks, April 3rd, it became the General Munitions Board. On July 27th, of the same year it was transformed into

the War Industries Board, Mr. Scott remaining Chairman throughout these transitions until October, 1917, when he was succeeded by Mr. Willard, who acted until the reorganization of the War Industries Board in March, 1918. In effect the War Industries Board was a general staff on the industrial and procurement side. Through it the leaders of the industries in the country were mobilized about the War and Navy procurement sections, and the intimate knowledge of industrial possibilities and conditions which these leaders of industry in civil life brought with them enabled the Board to recommend policies of priority of access to raw materials, control of prices, forms of contract, and selections of plants and facilities to be adapted to war work, which were essential. Later, of course, these policies were extended, and some of the activities initiated by the War Industries Board were committed to separate agencies, such as the Food and Fuel Administrations. In the main, however, an orderly development of plans laid by Mr. Scott and his associates, civil and military, avoided friction between the military and naval people on the one side and the civilians on the other, and it was rarely necessary for us to go back and start over or create different agencies. The start having been right in principle, its evolution was natural and adequate. Perhaps no small part of this experience was due to the fact that Mr. Scott, in addition to being a manufacturer with an intimate acquaintance among the leading industrial engineers of the country, was at the same time a student of history, and particularly military history, so that to his military and naval associates he spoke with sympathetic understanding of their problems and with a certainty about industrial processes which inspired their confidence.

Signal Corps Photo

Going Up to the Front

American Infantry and machine gunners are shown passing through a ruined town on their way to advanced position. (From the painting by Capt. Harvey Dunn.)

Another striking service was brought to us by Colonel Leonard P. Ayres. There had always been an exact and adequate record system in the War Department, to fix responsibilities and protect the Government. But as we now faced a tremendous program with speed as its essential element, we needed some concise and graphic means of seeing at a glance, from day to day, the progress, made in a thousand places, in details of the program, for delay anywhere might mean delay everywhere. Colonel Ayres brought us the modern science of statistics, with his own mastery of it. Soon we had daily production charts. It was no longer necessary to read columns of figures or to send for bureau chiefs. A glance showed every detail which needed attention and the relation of each detail to the possible progress of the whole vast program. Without this accurate and ordered knowledge, the problems of the War Department would have been too intricate for solution. Nor was its value limited to those charged with immediate responsibility. Senators, members of Congress and representatives of the press were kept abreast of all we were doing. To the rumors, anxieties and questionings, naturally current, the charts were the answer, and they told their story without the need of explanation or argument. Later Colonel Ayres performed a like service for the army overseas, at Tours and Chaumont. Thus we had the benefit of statistics, almost the youngest of the exact sciences, perhaps even more highly developed than it had as yet been in our great industrial organizations.

But when all is said that can be said for these beginnings, they were but tentative approaches to unknown problems. What was our part in the war to be? Our knowledge of the war in Europe was fairly detailed, but no great army, in the modern sense, had ever been transported and supplied across three thousand miles of ocean, nor had any ocean before ever been infested with submarines. The world's tonnage of ships was, at that time, disappearing. The early months of unrestricted submarine warfare caused mounting losses far greater than the replacement capacity of all Allied shipbuilding plants. The collapse of Russia and the failure of the Allied offensives in 1916 raised the question whether the war must not necessarily end before purely military assistance from the United States could be developed and transported. As a matter of fact, the real objective of both the Balfour and Viviani missions was to secure immediate financial assistance. The naval and military missions which accompanied them expected rather the moral value of the use of such military and naval forces as we had, than that we should really arrive, in time, in sufficient force to give military preponderance. *Time* was then to them, as it was with us to the end, the controlling factor, and our success lies not wholly in what we did, but also that we did it in time—the margin was very narrow!

The military members of the English and French mis-

sions spent many days in conference with corresponding sections of our War Department staff, giving us, in detail, the nature of the conflict and its demands both upon men and in the matter of supplies. Many of these officers remained in America and were joined by others, sent by their respective governments, to aid us in training and with advice in the technical supply services. But the expectation of the missions was very modest so far as an American army in France was concerned. Marshal Joffre urged upon me the early dispatch of "a regiment or perhaps even a division which could appear on the front with the American flag and arouse afresh the enthusiasm of the Allied soldiers." He told me that we need not delay for artillery, in which he understood that we were deficient, as France could easily supply all the guns we could need. Further, he told me that his government had arranged to place the port of La Pallice exclusively at our disposal, and that it would suffice for our needs until "you are ready to send over your great army, perhaps 500,000 men," when he promised additional port facilities. When one compares little La Pallice with the vast port facilities we built and used at St. Nazaire, Bordeaux, Brest, and elsewhere in France, the contrast between the expectation and the accomplishment is eloquent. Particularly it is eloquent of the foresight and imagination of General Pershing, who from the day he landed in France, seemed to grasp the needs of the situation with surer and larger views than any other person, military or civil, with whom I came into contact either at home or in Europe. In this respect, General Pershing shared and reflected the opinion of the General Staff in Washington. Both General Hugh L. Scott and General Tasker H. Bliss, Chief of Staff and Assistant Chief of Staff, throughout 1917, looked forward to the ultimate development of a large American army.

On the North Russian Front, 1918 *Signal Corps Photo.*

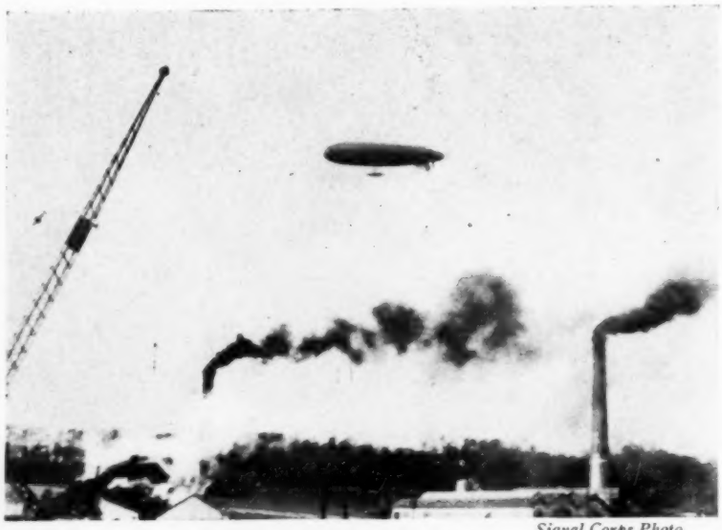
Graves of Mechanic Ignacy H. Kwasniewski, Private Anthony Soczkoski, and Private Philip Sokol, all of the 339th Infantry Regiment, the first three American soldiers killed in action on the North Russian Front, September 16, 1918.

After the suspension of diplomatic relations between the United States and Germany, General Scott, discussing with me the possibility of our entrance into the war, raised the question of the method by which men should be called to the service. He told me that, in his own view, there should be a draft law at the very outset and that we should avoid the British experience of starting out with the volunteer system and being later obliged to come to the draft. In this discussion I became convinced of the soundness of the suggestion and at once laid it before the President, who discussed it with me earnestly and at length and in the end approved the suggestion saying, "Have the law drawn at once so that, if I should be obliged to go to the Congress, I can refer to it in my message as a law ready to be presented for their consideration." The main outlines of the act were settled in a series of conferences in my office attended by General Scott, General Bliss, General Crowder, the Adjutant General, General McCain, and perhaps one or two others. The detailed preparation of the law was committed to General Crowder, and its later execution was also entrusted to him as Provost Marshal General. As it was necessary to fill up the organizations of the Regular Army and National Guard to wartime strength immediately, volunteering was permitted until the Selective Service law could be put into operation. No doubt there was some disappointment on the part of eager and devoted men that they were not permitted to form volunteer organizations, but the soundness of General Scott's suggestion was abundantly demonstrated. Our drafted army never came to be looked upon as made up of men who had been reluctant to volunteer, but rather as men selected, by orderly methods, to perform the duty common to us all of serving our country as our country needs us.

We had also to remember that the industries of the United States were indispensable sources of supply to the Allies as well as to ourselves. The disorganization of our factories and farms might well have had disastrous consequences to the peoples overseas. They were holding the line until our soldiers could arrive. The Selective Service law enabled us to preserve the continuity of our industrial processes and to console those who would have gladly turned from the lathe and the plough to active military service by assurances that they were performing their highest duty to their country by continuing their industrial occupations until they were called to the colors.

Thus, from the beginning, America's plan was the production of a large army, but the problem of transportation was long unsolved. The energy and ingenuity of our navy furnished the early transports which carried overseas the bulk of the American troops to provide the first invaluable reinforcement for the Allied armies at the time

of the crisis in the spring of 1918. But the final solution only came with the great German drive of March, 1918, when the necessity of the situation at last justified the diversion of Allied ships from every other use to build up the American Army in France. How great that necessity was is strikingly shown by the hazard which America then took. Never before in history has any country sent overseas an army larger than it was able to supply; yet that is exactly what America did. If the Germans had broken through, separating the French and British armies, our great forces in France would have been unable to subsist themselves. This hazard weighed heavily upon us all up to the very day of the Armistice. We had less cargo tonnage at our disposal than was necessary to feed and supply our overseas army, and we several times reached the point where the further transportation of soldiers without a corresponding increase of cargo tonnage for their support seemed impossible. Nevertheless, the army continued to be sent in increasing volume with the result that the war ended in 1918, and we escaped all that would have been implied in a prolongation of the conflict in 1919.



Signal Corps Photo.

Out to Sea to Meet a Convoy

Dirigible of the Army Transport Service is shown leaving Base Section No. 5, Brest, France, going to sea to meet a convoy of transports, October, 1918.

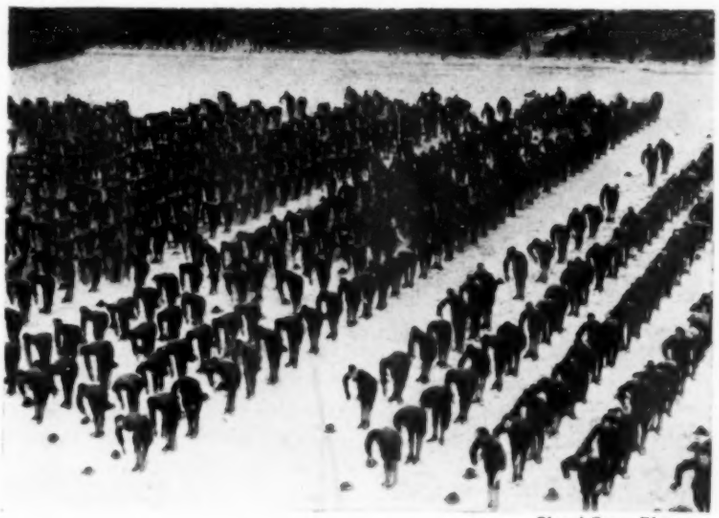
In October, 1918, when I was in France, a considerable part of my time was given to discussing with statesmen and soldiers of the Allied countries the plans for the 1919 campaign. In a little more than a month, the end had come and the daring of General Pershing in demanding and of General March in supplying a great American army was justified.

In the pages of Captain Frothingham's book, the parts played by General Pershing and General March, on the fighting front and the home front, are correlated. The method of their selection and their relations to the War Department, and through it to each other, justify description.

In France there is always kept in readiness a commander-in-chief designated to take command of the army in the next war. He has an office and a staff which is constantly working on the details of the first operations upon the outbreak of war. When war is declared, this commander sets out with his staff for the front and takes charge of the army as it mobilizes. The American Army has no commander-in-chief. The General Staff in Washington is an administrative agency, the Chief of Staff being in effect the military secretary of the President. The highest peace-time rank in our army is that of major general, and officers of the line of the army, in that rank, are in command of the corps areas into which the United States and its possessions are subdivided. Administratively, they are all under the direction of the Chief of the General Staff in Washington, but among them there is no priority of rank, and, of course, no one of them is ever designated in advance as a field commander in the unlikely exigency of war.

During the visit of the French and British missions immediately after our entrance into the war, it was determined to send at once an American contingent to France. This, of course, involved the selection of a commanding officer, and plainly the officer so selected might ultimately come to command great armies. When General Scott, as Chief of Staff, brought this matter to my attention, I asked him to have sent to my house the records of all the major generals and brigadier generals then on the active list of the army, and I spent evening and night hours on those records until I had ultimately made my own choice of General Pershing. Having decided the question in my own mind, I told General Scott, who at once replied, "You could not have made a better choice. General Pershing is a very able officer." I had never seen General Pershing, but his record showed him to be a man of robust health and energy. I, of course, had had direct and continuous opportunity to observe his conduct of the so-called Punitive Expedition into Mexico. The force of about ten thousand men, constituting that expedition, was the largest force which any American general officer at that time in active service had ever commanded. The mission with which General Pershing was entrusted in Mexico required the highest qualities of the soldier and many of the qualities of the statesman. Primarily, of course, the expedition was organized to capture the bandit Villa as a means of discouraging, if not preventing, raids into the United States across the Mexican border by the partisan bands and bandit groups which were harassing Mexico in the profoundly disturbed state of that country. When Villa fled to the mountains, the Punitive Expedition was retained in Mexico as a warning and to prevent other bands from undertaking to repeat his raid. It was, therefore, important that General Pershing's expedition should remain as far south as possible without straining to the breaking point the reluctant tolerance of such authorities as there were in Mexico of this seeming invasion of their country. The Carranza Government was unable to guarantee our border against violence. Nevertheless, it was sensitive to the presence of any American forces on Mexican soil and perhaps suspicious that the Government of the United

States had purposes other than the mere pursuit of Villa, General Pershing's task in Mexico therefore required tact, sympathy, and self-restraint. His force, though small, was splendidly equipped and no doubt was superior to any force which might have been brought against it at that time by Mexico. The President, determined to protect the border, was nevertheless anxious that there should be no war between the United States and Mexico. With the rest of the world in flames, peace in the Americas must be maintained. The administrations of President Taft and President Wilson both pursued the policy of patience with Mexico, in the hope that forces of order would gradually solidify, and both administrations pursued a policy of friendship toward Mexico in her difficulties. General Pershing's loyalty to this policy and to these purposes throughout the whole period of the Punitive Expedition showed at once his tact, his self-restraint and his subordination of the purely military aspects of the problem to the political aspects which were in the hands of his civil chiefs.



Signal Corps Photo.

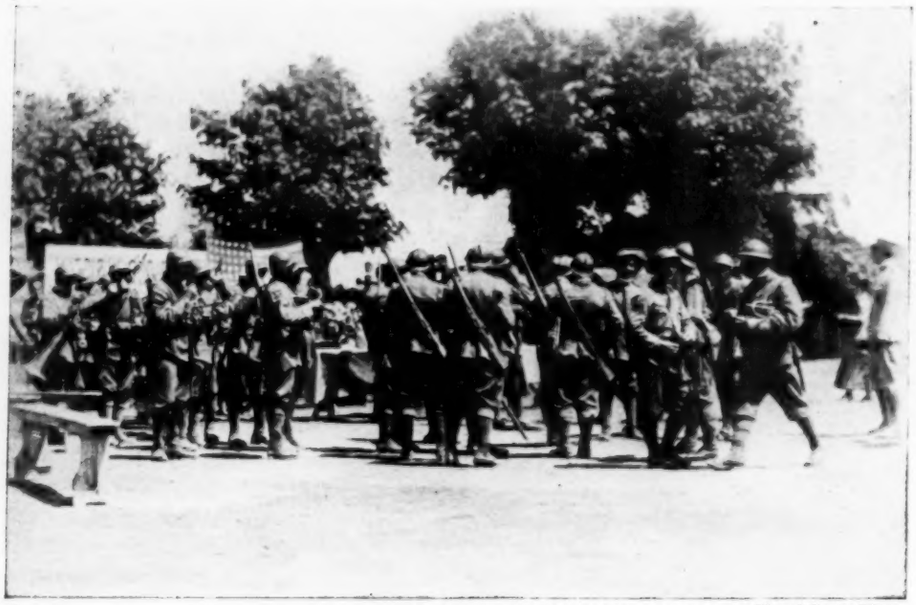
The Metamorphosis, 1918

Members of the American National Army, ten thousand strong, going through setting-up exercises during their transition to perfect physique.

My father was a Confederate soldier, a mere boy even at the close of the Civil War. Being a man of very robust common sense, he quickly readjusted himself to the results of the war, and became of all men the most thoroughly reconstructed, repeatedly saying to me, when I was a child, that it was a great blessing that the war had turned out as it did. While a very busy country doctor, he nevertheless read practically every book of importance which came out about the Civil War, and, as I grew up, he read them aloud to me or listened as I read them. Many times, during our reading and discussion, he remarked to me that the superior good fortune of the Confederate Army was undoubtedly due in substantial part to the free hand given General Lee, after a single effort on the part of Jefferson Davis to interfere with strictly military operations, and that the military meddling of Stanton and Halleck had been a serious handicap to the Union commanders. When General Pershing went overseas, I told him that story and told him that I would endeavour to do everything I could on this side to make his task easier, but that I would not myself interfere with his administration of military questions or permit them to be interfered with by my military associates on this side. General Pershing has often said that this relation between us was most helpful to him, and I have many times been interested to reflect that the lesson which my father had taught me when I was a mere child did prove helpful in great matters which neither he nor I, of course, could have forseen.

With this lesson remaining in my mind, I found myself thinking, from the beginning, that, having selected General Pershing and sent him overseas, my duty was to give him power in proportion to his responsibility, to refrain from interfering with him, and to protect him from interference. Happily, the views of the chiefs of staff and of the General Staff in the War Department were in complete harmony with this theory of the relation between the commander in the field and the Department. How far we were able at all times to live up to this theory is of course a matter of official record and needs no comment here. The War Department and General Pershing's headquarters were connected by cable lines which carried, day and night without interruption, a continuous interchange of messages showing General Pershing's expanding needs and giving in detail his reports of the progress of his industrial and military operations; but I doubt whether in a single cabled message from the War Department to General Pershing, there will be found even a suggestion as to any purely military operations under his direction. He was in France and the War Department three thousand miles away from the place where his decisions had to be made and his actions taken. In this, of course, he differed from the Union Commanders, who were at the head of armies fighting around Washington, and were often, therefore, in contact with and always within immediate reach of Secretary Stanton and General Halleck. General Pershing's situation reminded me of that of General Kutuzof, who, while commanding the Russian armies around Moscow, received one day from the Czar an autographed letter giving in great detail a plan formed by the Czar for the rout and capture of Napoleon's army. Kutuzof, having read the communication, turned it over and wrote on the back, "Sire, plans formed at a great distance are often difficult of execution," and returned it to the Czar. The fact is that, while we thought and still think of the World War from the battle of the Marne to the March, 1918, offensive as a stabilized, if not stalemated, operation, nevertheless, the details of the situation were constantly changing and differing, and no helpful suggestions could have been expected from the General Staff in Washington upon situations which had to be solved with reference to their condition at the moment of action.

Of course, General Pershing's designation for the command in France was made by the President, to whom I reported my own recommendation. The President discussed with me both the size of the first expedition and



Signal Corps Photo.

Italian Bersaglieri Band receiving coffee, doughnuts and cigarettes from the American Red Cross. Villafranca, Italy. July, 1918.

the qualities which its commander would need. He inquired into the basis and method of my own selection and referred with constant approval to the difficult service of General Pershing in Mexico. He approved the choice, and from that day General Pershing had his unwavering confidence and full support. In return, General Pershing gave devoted service and unquestioning loyalty, both personally and officially, to his Commander-in-Chief.

The selection of General Peyton C. March, to be Chief of Staff in Washington in 1918, grew out of my contacts with him in 1916, when he was a colonel in the Adjutant General's office in Washington. At that time he was particularly charged with the duty of revising and cutting down the enormous amount of paper work involved in the army system of records. When I became Secretary of War, the Chief of Staff was General Hugh L. Scott, a man of exalted character, deeply steeped in the traditions of the old army, and having the confidence of the army in his disinterested and impersonal fairness. From April, 1916, on, General Scott and I were in intimate daily contact, and he undertook, with infinite patience and affectionate kindness, the task of acquainting me with the traditions of the military service and the qualities and characteristics of the army's personnel. From him I learned to understand and admire the completeness of Colonel March's grasp of the details of War Department business and the boldness and simplicity with which he reformed the intricate record system which had grown up in the course of years. Colonel March went to the Mexican border, when we mobilized the National Guard there, and finally went to France, where he became, by General Pershing's selection, Chief of Artillery in the Expeditionary Force. General Scott's term as Chief of Staff ended in October, 1917, with his compulsory retirement from the active service under the age limit fixed by Congress, but he was immediately recalled to the active service and placed in command at Camp Dix. He was succeeded as Chief of Staff by General Tasker H. Bliss, a scholarly and sagacious counsellor, with a long record of foreign service both administrative and military. But General Bliss's retirement was also approaching, and his transfer to the Supreme War Council at Versailles, as our military representative there, was from all points of view the happiest possible selection. As this second vacancy in the office of Chief of Staff approached, it seemed to me that the time had come when we should have in Washington an energetic and effective administrator, who by actual experience in General Pershing's army knew the situation in France, was acquainted with General Pershing's plans, and so could more effectively direct our coöperation with the Expeditionary Force. I therefore wrote to General Pershing and requested that General March be permitted to return to the United States to become Chief of Staff. General Pershing approved the choice but regretted the loss of his Chief of Artillery. In the long run, the sacrifice in France was justified by the achievements of General March in Washington.

Throughout the entire period of our participation in the war there was constant discussion as to the wisdom and possibility of brigading American troops with the British and French armies. I do not know how early the suggestion from abroad was first made, but the American policy on that subject was settled before the first American soldier went overseas, and settled upon grounds so obviously right that no departure from it was at any time possible. After General Pershing had reported to the War Department and been notified of his selection, he remained in Washington some weeks and participated in frequent conferences with the Chief of Staff and other members of the general staff, while he was selecting the officers who were to accompany him, and generally making his plans. In these conferences, the whole question as to the size and form of the American effort were thoroughly considered. As the scene of operations was to be in France, it was of course recognized that our army would have to conform its movements to the front as established in the years of the war which had already elapsed. Belgium and Great Britain had special objectives which dictated the part of the defensive line they should occupy, and for clear reasons the actual defense of Paris would have to rest upon the French Army. But even at that stage it was clear that the American Army should constitute an independent force and that we should all look forward to a time when it would operate independently, but in unison with the armies of the Allied and Associated Powers. The orders given to General Pershing when he went overseas were drawn by General

Francis J. Kernan. They have always seemed to me to be a model in their breadth of view, their clarity and conciseness. It was never necessary to change or even to amplify a single sentence in those orders. The complete order was as follows:

From: The Secretary of War.

To: Maj. Gen. J. J. Pershing, United States Army.

Subject: Command, authority, and duties in Europe.

The President directs me to communicate to you the following:

1. The President designates you to command all the land forces of the United States operating in continental Europe and in the United Kingdom of Great Britain and Ireland, including any part of the Marine Corps which may be detached for service there with the Army. From your command are excepted the military attachés and others of the Army who may be on duty directly with our several embassies.

Signal Corps Photo.

Citizens of Luxembourg marching in a parade of welcome to American soldiers. Luxembourg, November 21, 1918.

2. You will proceed with your staff to Europe. Upon arrival in Great Britain, France, or any other of the countries at war with the Imperial German Government, you will at once place yourself in communication with the American Embassy and through its agency with the authorities of any country to which forces of the United States may be sent.

3. You are invested with the authority and duties devolved by the laws, regulations, orders, and customs of the United States upon the commander of an army in the field in time of war and with the authority and duties in like manner devolved upon department commanders in peace and war, including the special authorities and duties assigned to the commander of the Philippine Department in so far as the same are applicable to the particular circumstances of your command.

4. You will establish, after consultation with the French War Office, all necessary bases, lines of communication, depots, etc., and make all the incidental arrangements essential to active participation at the front.

5. In military operations against the Imperial German Government you are directed to coöperate with the forces of the other countries employed against that enemy; but in so doing *the underlying idea must be kept in view that the forces of the United States are a separate and distinct component of the combined forces, the identity of which must be preserved.* This fundamental rule is subject to such minor exceptions in particular circumstances as your judgment may approve. The decision as to when your command, or any of its parts, is ready for action is confided to you, and you will exercise full discretion in determining the manner of coöperation. But, until the forces of the United States are in your judgment sufficiently strong to warrant operations as an independent command, it is understood that you will coöperate as a component of whatever army you may be assigned to by the French Government.

6. You will keep the department fully advised of all that concerns your command, and will communicate your recommendations freely and directly to the department. And, in general, you are vested with all necessary authority to carry on the war vigorously in harmony with the spirit of these instructions and toward a victorious conclusion.

I have underscored in paragraph five of the foregoing the sentence which it is here desired to emphasize. It imposed almost the only limitation upon the complete authority given to General Pershing, although it was a limitation with which he himself was in entire accord.

The reasons for this determination were many. The Allied and Associated Powers had a common object, which was the defeat of the armies of the Central Powers, but they had diverse objectives, and it was quite inconceivable that the American Army should ever be so merged under French and British command, that it could ever be used to carry out operations or further purposes with which the Government of the United States was not in complete sympathy. There was, of course, no such diversity of sympathy apparent, but many things change in the course of a war, and it was necessary at all times to preserve the independence and identity of the American forces so that they could never be anything but an instrument of a policy of the United States.

Public opinion would not have sustained and ought not to have sustained turning over American soldiers to be lost in British and French commands. Nor would American soldiers have been happy under any flag but their own. The whole theory of our Army differed from the theories of the French and British just as we as a people differ from them. Our habits of diet, discipline, training, and recreation all differ from theirs, and an immeasurable loss

to the cause would have been sustained if the American spirit which sent our soldiers singing to the front had been lost and the pride of our soldiers in their country and its cause dulled by the men themselves being used as mere replacements in foreign armies.

One further, but important, consideration should be mentioned. General Pershing and General March in Washington agreed in believing that the war was to be won on the Western Front, and that, in order to win it, military preponderance had to be established there for the Allied armies. This preponderance could be brought about only by maintaining the strength of the British and French armies at what they were when we entered the war, so that the American Army became a constantly added force rather than a mere replacement. France and Great Britain had been in the war long, devastating years. It would not have been unnatural for them to be willing to see their decimated divisions brought to war strength with fresh men from the United States, but that would merely have maintained the balance between the opposing forces while the critical and necessary thing was to secure preponderance. By maintaining the separation and independence of the American forces, it was possible at all times to be sure that the British and French manpower was being used to the full, and that the growing American Army assured that ultimate preponderance in rifle strength which was necessary to success. These reasons all seem so conclusive and obvious that it would not be worth while to recount them but for the fact that practically to the day of the Armistice, in London, in Paris, and in Washington, representatives of Great Britain and France continued to urge, with more or less fervor, the brigading of American troops into their respective armies. General Pershing, of course, refused to accede to these representations when they were made to him, and President Wilson refused to interfere, leaving the whole question to be determined by General Pershing under the responsibility committed to him, and in view of the exigencies of the situation as they appeared in the actual field of battle. In October, 1918, I called upon M. Clemenceau in Paris to discuss questions of horses, airplane engines, and other material for the campaign of 1919. When we had finished the conference, M. Clemenceau said to me, half playfully, that he thought the United States had produced the two most stubborn men in the world. I told him I thought the countries with which we were associated in the war had eminent candidates for the distinction, but asked him who his American favorites were. He replied, "President Wilson and General Pershing," and sought to prove his case by showing how obdurate they were against the advice of statesmen and soldiers alike in the matter of distributing American troops to French commands. Two weeks earlier, Mr. Lloyd George had as earnestly pressed the same view upon me. Practically up to the Armistice, this question continued to be debated, although, except in temporary emergencies and under special circumstances, the policy, established by America when we entered the war, was never departed from and never was in any danger of being yielded.

In Chapter XVII of this book, Captain Frothingham refers to the Commission on Training Camp Activities. Work of this kind really began with the mobilization of our National Guard on the Mexican border in 1916. Many of the National Guard regiments were from cities in which there had been effective acceptance of the belief that the provision of wholesome recreational opportunity was both a part of the community's obligation to its citizens and also a very substantial part of the community's insurance against the growth of crime and vice among the young. As I had spent fifteen years in the service of such a city I was thoroughly familiar with the programs and activities of the so-called "social workers," I had long realized that the tendency of youth is spontaneously upward, and believed the encouragement of wholesome opportunity was far better social discipline than multiplied restraints upon the leisure activities of the young. General Hugh L. Scott, who was Chief of Staff when I became Secretary of War, had the highest idea of and ideals for the common soldier of any man with whom I ever came in contact. He had a certain sturdy ruggedness in dealing with "soldier men," which meant no pampering or coddling, but he believed soldiers to be men, expected manliness of them, and had a compassionate comprehension of their shortcomings which made him very eager in his sympathy with every suggested opportunity for them to have a broader chance for self-culture and a stimulus to self-discipline.

Almost as soon as the National Guard moved to the border, Mr. Raymond B. Fosdick, with whom I had long been associated in the study of police and other disciplinary and social questions, called on me in the War Department to say that he thought it unfair that the National Guard should be subjected to the temptations which inevitably tend to grow up about soldiers' camps in places remote from their homes. I therefore asked him to go to the border and make a comprehensive study of conditions for my information. This he did. When he made his report, I asked him to go back to the border and take up with General Funston and with General Pershing, who was then in Mexico, the question of a radical change in the surroundings of our camps. Mr. Fosdick found that General Funston had a formula to the effect that "Soldiers will be soldiers," and it took some persuasion from Mr. Fosdick and from me to convince General Funston that he had nothing to fear from the "uplifters" and "welfare workers," but he was finally convinced and became radical enough to satisfy both Mr. Fosdick and me, as he cleaned up the border. General Pershing at once accepted the point of view presented to him by Mr. Fosdick and, as a consequence, when General Pershing went overseas, he was determined from the outset that the army should be wholesome and that his men, far separated from their home and from the restaints of neighbourhood environment, should not be driven or drawn into the temptations which surround unoccupied leisure. Thus it was that at home and abroad there was both civilian and military sympathy for the aims of the Commission on Training Camp Activities.

Mr. André Tardieu, in a recent book, has commented upon the existence in America of social workers and welfare agencies as a distinctive characteristic of our civilization. There is apparently no analogue to these things in France, and Mr. Tardieu expresses admiring surprise at their zeal and effectiveness in the United States. In

this observation he is clearly right. Every community in America near a cantonment or camp during the war organized itself around the camp and adopted the soldiers into their community and social life. As the organization and training of the army went on, therefore, it was natural that there should be built up around it social substitutes for the home influences which were being left behind. After the army went overseas, these institutions followed it, both in the extended activities of the great welfare organizations and in the direct provision for soldiers' welfare afforded by the Commission on Training Camp Activities.

Far up in the front lines in France, I one day visited a detached regiment of about twenty-five hundred men who were scattered about a village and its adjacent farms. There was presented to me there a fine, intelligent American girl, who was with the regiment as mother, sister, and confidant to the entire outfit. I asked her whether she did not feel lonely and afraid, in so remote and so dangerous a place, the only woman with a whole regiment of men. She replied smilingly that she was the safest woman in the world, that "her boys" to the last one would protect her with their lives, and that each evening a voluntary detail of four soldiers was placed by the men themselves to guard her quarters and to accompany her, if duty called her to make visits by night from one part to another of the regiment. Later, after the war was over, at a dinner table in Paris I told this incident. One of the dinner guests said, "Mr. Secretary, I have been in charge of all the women in France associated in any way with the army. I could parallel your story by a thousand others. Indeed, I have talked with every American woman in any way connected with the army, and so far from any one of them ever having had an unpleasant experience, the universal testimony is that no one of them has ever had an uncivil word from a soldier."

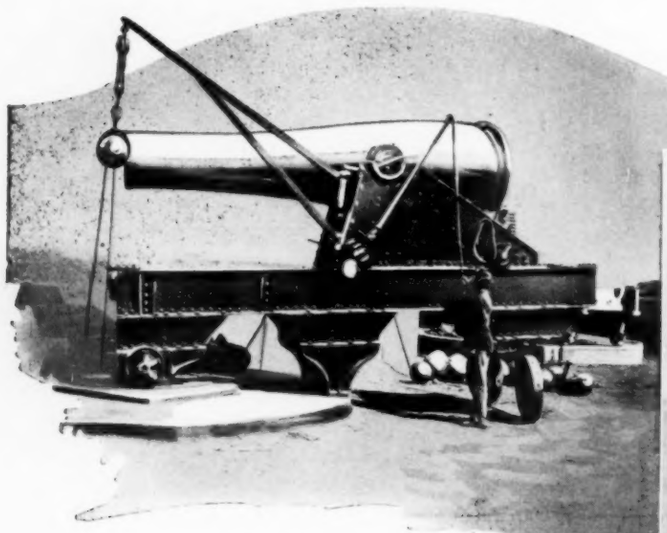
I trust some day the history of the social side of our army in the great war will be written. If Mr. Fosdick does not write it, it should be written around his splendid service. Should the story ever be fully told, it will picture the most distinctly American thing about our whole participation in the war. America's wealth, her industrial supremacy, her splendid detachment and unselfishness of purpose, and the inexhaustible stream of robust youth which we supplied in the war were all great contributions. The mobilization of the scientific forces of the country around the army in the matter of supplies and medical attention is also a great story. But never before in the history of war has the elevated atmosphere of home been taken into the soldiers' camp, and the social consequences of this fact to us in America are immeasurably important.

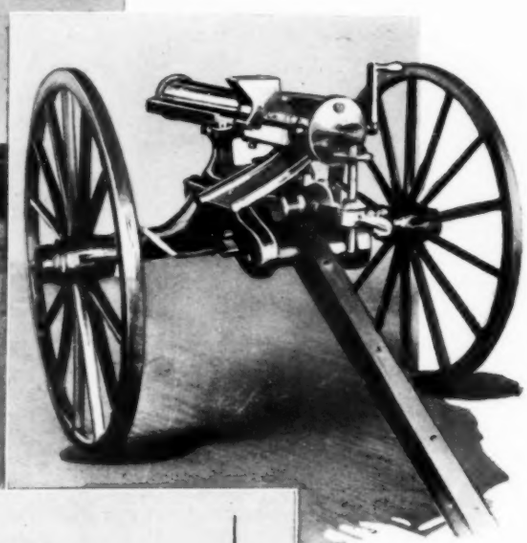
With each new book about our participation in the war some new touch is given and some wider view permitted of the vast and magnificent achievement. Captain Frothingham has cut a new path, particularly in his correlations of the various activities, industrial, social, military, and naval, which had to be brought about for the effective assertion of our national power. But I doubt whether all the histories that can be written will ever quite convey to the generations who must learn of the war by reading about it, the unity of purpose and the fineness of spirit which our great American democracy developed in that crisis. Only those who lived in its light and felt its strength about them can ever know the full intoxication of being an American when America is at her very best.

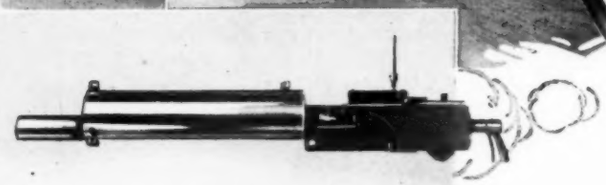
In the foregoing I have not undertaken to recall, much less to weigh, the services rendered by individuals to the War Department and through it to the country. Time, however long, would be too short to recall and adequately to describe those services. I have therefore rigidly kept within the limits of a prefatory note and have included the names of individuals only where they were essential to the description of the particular incidents or problems commented upon. As for the rest of the great company with whom I was privileged to serve, military, naval, and civilian, I can, as to their services, at the moment do nothing better than take refuge in the rule of evidence: *res ipsa loquitur.*

Signal Corps Photo.

The Car in which the Armistice was Signed. Marshal Foch's Train Arrives at Compiegne, November 11, 1918.

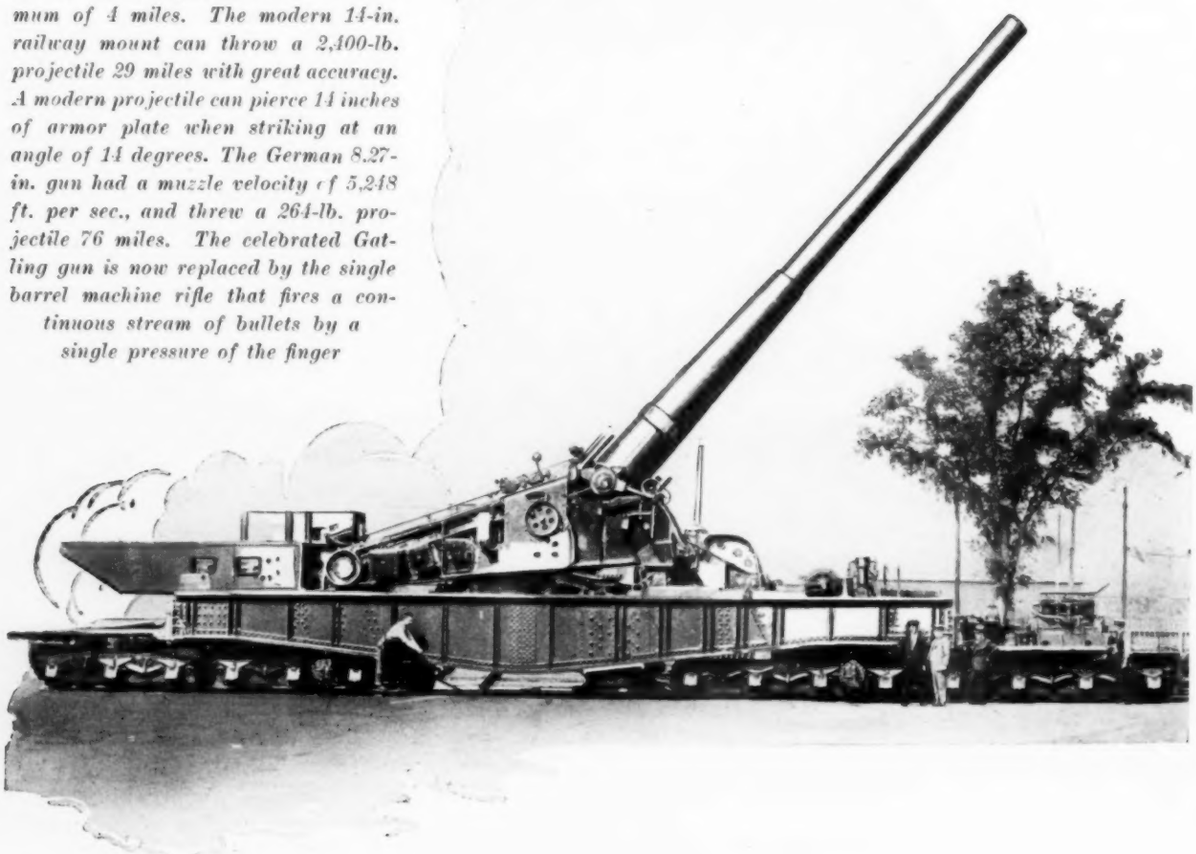






Ordnance—Old and New

Fifty years ago recoil mechanisms, breach-loading rifles, metallic cartridges, and smokeless powders were just coming into use. Alloy steels, modern forging methods, and accurate production machinery have made possible the use of high explosives, and have secured accuracy of fire. The first American railway mount fired a 13-in., 220-lb. spherical shell a maximum of 4 miles. The modern 14-in. railway mount can throw a 2,400-lb. projectile 29 miles with great accuracy. A modern projectile can pierce 14 inches of armor plate when striking at an angle of 14 degrees. The German 8.27-in. gun had a muzzle velocity of 5,248 ft. per sec., and threw a 264-lb. projectile 76 miles. The celebrated Gatling gun is now replaced by the single barrel machine rifle that fires a continuous stream of bullets by a single pressure of the finger



1927 Ordnance

A Review of Ordnance Progress During the Past Year

By Maj. Gen. C. C. Williams,* U. S. A.

BALANCING all the happenings in the Ordnance Department during the past year, I have the conviction that material progress has been made. The condition of the arsenals as to the volume of work is improving constantly. We have now one establishment, the Frankford Arsenal, running at capacity, in the manufacture of small arms ammunition. Provision has been made by the Congress for the rehabilitation of the Picatinny Arsenal and when this arsenal is rebuilt in accordance with present plans the Ordnance Department can be assured that it has a well rounded out and an efficient ammunition development arsenal.

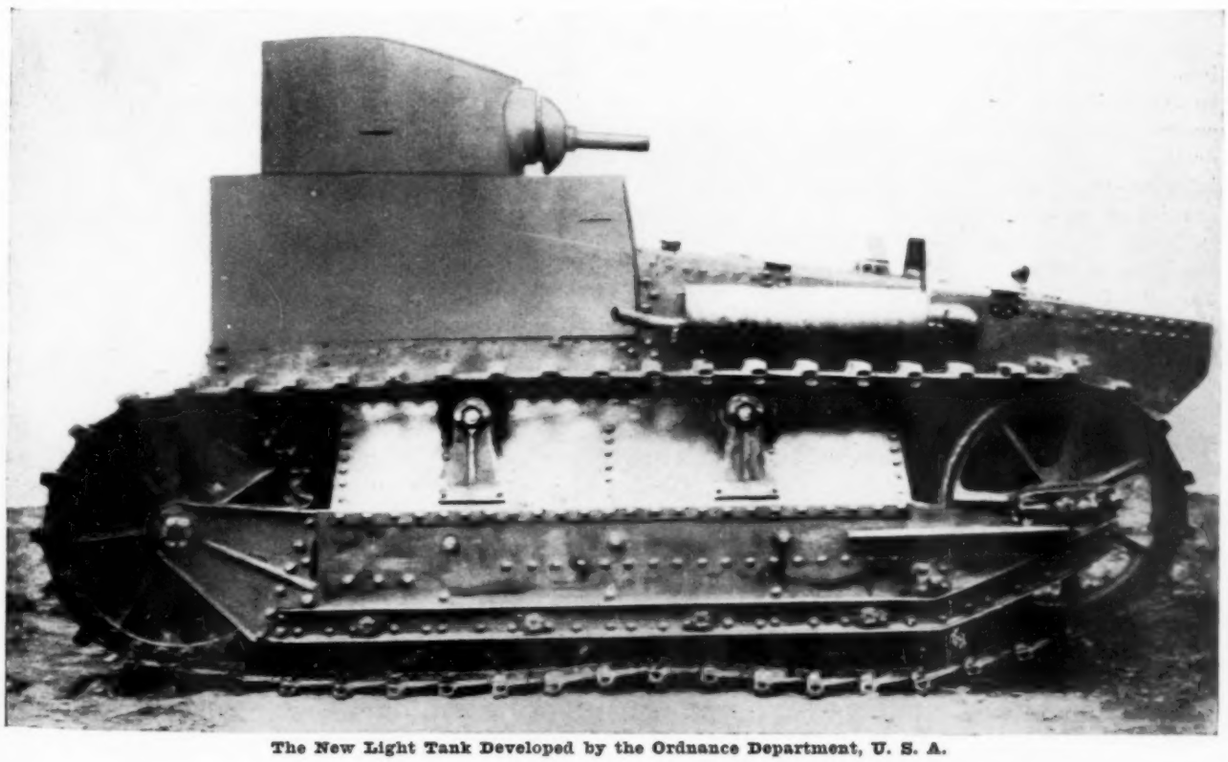
Since money is the motive power of every organization, I will say a few words about the money affairs of the Ordnance Department. Under the budget system now in vogue the Department has in my opinion been treated fairly. The appropriations each year have been increased and the estimates now being submitted to the Congress are almost three millions of dollars more than was appropriated for the fiscal year 1928. It would look at this time as if the operations of the Ordnance Department for one year would represent an expenditure of something like fifteen millions of dollars which is more than twice the amount we had for expenditure in 1924. In the estimates for the fiscal year 1929 recognition has been given to several very important projects such as the ten year development and extended service test project and the project for preservation of the war reserve of ammunition.

Perhaps some have thought at times that we spend too much time in the preparation of estimate data. I do not agree with this idea since it is not possible in my opinion to put too much thought and effort in the arrangement of our needs for funds and in preparing the data to set forth these needs to the various estimating agencies as well as to the Congress. Incidentally this work of preparing estimates results necessarily in a careful examination of our plans and programs and makes us examine ourselves possibly more carefully than we would otherwise.

As a matter of fact, I believe now that our estimates and our estimating efforts are very well standardized and are quite efficient. At this point I would like to inject a note of caution that we must devote the same degree of care and attention to seeing that our funds are spent properly and that the programs for which we estimate are carried out with the funds thus secured.

THE principal change which has been made in the assignment of personnel during the past year was the assignment of ten additional officers to industrial procurement. Three of these officers are assigned to indus-

*Chief of Ordnance, U. S. A.



The New Light Tank Developed by the Ordnance Department, U. S. A.

trial plants, one with the Westinghouse Electric and Manufacturing Company, one with the Warner and Swasey Company, the Brown Hoisting Machinery Company and the American Multigraph Company, and one who will divide his time between the Scovill Manufacturing Company, Pratt and Whitney, and Brown and Sharpe. These officers are studying production engineering and it is believed that the training and experience which they receive will prove of great value to the Ordnance Department.

Six Wheel Chevrolet Cross-Country truck, 1500-lb. capacity—a recent adaptation by the Ordnance Department, U. S. A., of a standard commercial vehicle to meet exacting cargo-carrying demands of Army service.

The change in the course at the Ordnance School went into effect in the fall of 1926, but this change did not become fully effective in Course II until this year. In general, the change in Course I consisted of the introduction of additional work in chemical engineering, the introduction of a course in machine design, and the broadening of the more fundamental parts of the other subjects. The change in Course II consisted largely of the introduction of a nine weeks' course in Field Service activities at the Ordnance Specialists' School at Raritan Arsenal, and a course of six weeks in ordnance engineering at Watertown. The time for these additional courses was obtained by reducing materially the time spent in the foundry and by consolidating certain of the other courses.

The Ordnance School in the past has not allotted time properly to prepare its graduates for duty with the line or for Field Service activities. The new course at the Ordnance Specialists' School includes preparing students for the inspection and maintenance of matériel in order that they may properly represent the Ordnance Department with the other branches of the Army.

One of the most satisfactory changes in Course II is the introduction of a course in economic principles, the history of industry and commerce, industrial organization, and the principles of management. This consists of a series of 18 lectures, conferences and recitations at the Harvard Graduate School of Business Administration. This course is given by a very able member of the Harvard faculty and instruction is by the case method. Apparently this course is exceedingly satisfactory and should be of great value to the student officers.

During the past year 48 students were enrolled in the specialists' courses at the Ordnance Specialists' School, 23 in the non-commissioned officers' courses, 2 in the course for National Guard officers, 10 in a course for Navy petty officers, 43 in a course for enlisted men of the Second Corps Area, and 11 in a two weeks' training period for reserve officers. The equipment of the school is sufficient to handle additional students without a proportionate increase in overhead expense or personnel. Unfortunately, the demand for Ordnance enlisted men is so great that it has been found exceedingly difficult to spare as many men from their organizations as it is desirable to train at the school. During the past year special arrangements have been made with the Adjutant General whereby 83 men with satisfactory educational and personal qualifications were recruited especially for assignment as students at the Ordnance Specialists' School. It is expected that about 70 of these men will be graduated in June and will be available for assignment to various organizations. The receipt of trained men who still have two years to serve in their current enlistment should be very welcome to organization commanders. This will improve materially conditions at foreign service stations, as it will not be necessary for organization commanders to spend the greater part of an enlisted man's foreign service in training him so that he can be used effectively during only a short portion thereof.

In compliance with War Department instructions a new training program for R. O. T. C. students has been prepared in such form that it may be published, together with training programs of other branches, in one publication. Little change has been made in the general character of the R. O. T. C. courses. Emphasis has been placed continually upon the desirability of increasing the amount of instruction which will prepare students for service with troops.

There are now 2,943 officers in the Ordnance Department Reserve, of whom 1,554 are in the Branch Assignment Group and 1,389 in the Territorial Assignment Group. This represents an increase of 185 officers during the past year. Considerable improvement has been

noted in the personnel of the Ordnance Department Reserve. Many unqualified and uninterested officers have been dropped, and great care has been used in the selection of officers for appointment and for promotion.

DURING the past year very marked progress has been made in our automotive development program. The preliminary design of a light tank chassis was approved in December, 1926, by the Chief of Infantry. In the following April the contract for its manufacture was awarded to the Cunningham Motor Car Company. One hundred and eight days later the chassis was operated under its own power.

The Medium Tank 23-ton T1 has been completed, and after shop tests at Rock Island Arsenal, has undergone a Proving Ground test of 400 miles. The tank is now at Camp Meade undergoing test by the Tank Board, and we understand that it has been favorably received. The characteristics of the tank as regards weight, speed, armor and armament are practically identical with the Medium "A," 1921.

Tests of various commercial tractors and trailers have been carried on throughout the year by the Proving Ground, and by the various Service Boards, in order that we may keep well informed as to the suitability of commercial types.

Two standard one-ton Chevrolet trucks have been modified by the addition of a rear driven axle, and are now under test by the Field Artillery and Infantry Boards. This development is an effort to secure a light truck suitable for cross-country maneuvers. These vehicles have been so well received that we are now modifying two additional trucks and fitting them with the largest tires adaptable to the standard wheels.

The cross-country car is being well received by the Service, and a few additional units have been issued.

IN the past year intensive antiaircraft firing tests have again been conducted under joint Coast Artillery, Air Corps, and Ordnance Department programs. In the first test, which was held at Fort Tilden in 1925, the antiaircraft artillery and fire control then in the hands of the Service were used. A sufficiently large number of rounds was fired to insure that the conclusions to be drawn from the tests would be reliable. These tests furnished a measuring scale or base line to be used for comparing the results of future tests. In 1926 and 1927 extensive firing tests were conducted at the Aberdeen Proving Ground using new and experimental guns, carriages, and fire control. The results of the 1926 exercises are now well known. The detailed report of the 1927 tests is now being written and will be published later.

The results of the last two years' tests may be summarized briefly as follows:

The test of the 3-inch antiaircraft gun on fixed mount was concluded this year. This four-gun battery was fired over 10,000 rounds with practically no failures. These exercises have demonstrated that this gun and carriage represent fully developed matériel which can be issued to the Service with confidence.

During this period an entirely new system of fire control for antiaircraft guns has been developed, manufactured, and tested. The whole system is known as the Case III method of fire. The Case I system, formerly employed, will no longer be used, and I am given to understand that the Coast Artillery Corps will recommend that the sights formerly provided for 3-inch fixed guns be entirely eliminated.

During these exercises the Wilson antiaircraft fire-control director, designed and developed by the late Major W. P. Wilson, of the Ordnance Department, was extensively tested. The brilliance of Major Wilson's work on this antiaircraft director is well appreciated, I believe, by the officers of the Ordnance Department, and it is a severe loss to the Department that Major Wilson's work has been interrupted by his untimely death. The Department will endeavor to carry on Major Wilson's work to the best of its ability.

The Fire-Control Director T1—the creation of the late Maj. Wm. P. Wilson, Ord. Dept., U. S. A. The instrument is shown here equipped with Sperry Azimuth Transmitter.

Two 105-mm. antiaircraft guns and carriages were provided for this year's program. The 105-mm. gun is the longest gun in calibers (60 calibers long) manufactured to date in this country. This gun was made by the cold-worked process and is equipped with a loose liner. The tests indicate that the 105-mm. matériel is destined to perform an important role in antiaircraft defense for combating planes at high altitudes and long ranges. The using Service has found that the 105-mm. gun and mount are satisfactory, and these units are now standards of manufacture.

The 3-inch antiaircraft gun and mobile carriage were completed in time for test this year. The gun and carriage were found to be satisfactory with the using Service and are now being standardized.

Several of the antiaircraft guns used during these tests were manufactured by the cold-worked process.

These guns have proven entirely satisfactory, as have all of the forty or more guns of various calibers which have been built in the last four years by this method. The 3-inch and 105-mm. guns have been fitted successfully with loose liners, which can be removed in the field. The development of the loose liner for the antiaircraft gun is believed to be of first importance, since this method of gun construction permits the worn-out gun to be quickly relined, thus making the use of high muzzle velocities practicable.

Design work was promptly inaugurated, and by 1921 the first pilot carriages began to arrive at the Aberdeen Proving Ground for test. These first attempts to produce new weapons to meet the stringent requirements of modern warfare, while not entirely satisfactory, were in many ways most gratifying. It was found that we could build cannon with greatly increased ranges, and at the same time keep the weights within the limits imposed by the demands for mobility.

In connection with these developments, many very im-

This—the 105-mm. Antiaircraft Gun on Mount T1—is a recent arrival in the family of antiaircraft weapons developed by the Ordnance Department, U. S. A.

By applying electrical data transmission and follow-the-pointer system to machine guns, and by the use of more exact fire-control instruments, the percentage of hits with machine guns has been more than doubled, giving indications that future development of fire-control instruments will result in improved accuracy of fire.

By the close coöperation of the Chief of Coast Artillery and the Ordnance Department, and by the two extensive firing tests held at the Aberdeen Proving Ground, with regular antiaircraft troops, it has been possible in two years' time to evolve entirely new antiaircraft guns, carriages, and fire-control equipment. The major items of this matériel have been standardized and the Department stands in a position to equip our antiaircraft regiments, when funds are made available, with highly developed matériel, the efficiency of which has been fully established by extensive firing tests.

THE development of mobile artillery matériel since the close of the World War has been generally along the lines of the approved recommendations contained in the Caliber Board Report. These nine years consequently have been a period of intense activity in artillery development for the Ordnance Department, as greatly improved weapons of every caliber required by the Army, were called for. The characteristics prescribed by the Caliber Board Report for these new weapons were far in advance of any known existing types, and of any types used by other armies of the world.

portant basic features of design had to be worked out and decided upon, such as whether or not the field carriage should mount interchangeably both a gun and a howitzer; the relative merits of the box trail and the split trail types of carriage; the elevations necessary for guns and howitzers; and the methods of transporting the heavier calibers, whether in single or double loads. The combat branches and the Ordnance Department have been drawn very closely together by their mutual interests in this absorbing subject of developing improved matériel, and we appreciate very greatly the fine spirit of coöperation which has been shown the Ordnance Department by the using Services.

From the time of the first appearance of these new pilot weapons, great progress has been made in the gradual evolution toward simple, practical weapons having the characteristics required by the Caliber Board Report, and at the same time embodying rigidity, strength, and maneuverability necessary for successful service weapons. This extensive artillery development program is now nearing completion, and many of these newly developed artillery weapons are being standardized and adopted by the War Department as new service types. Generally speaking, some preference has been given to perfecting the artillery weapons accompanying divisional troops. Work on the heavier corps and army types, however, has been carried on as rapidly as funds would permit, and the final perfection and adoption of these new heavy types should follow very closely the adoption of the new light types.

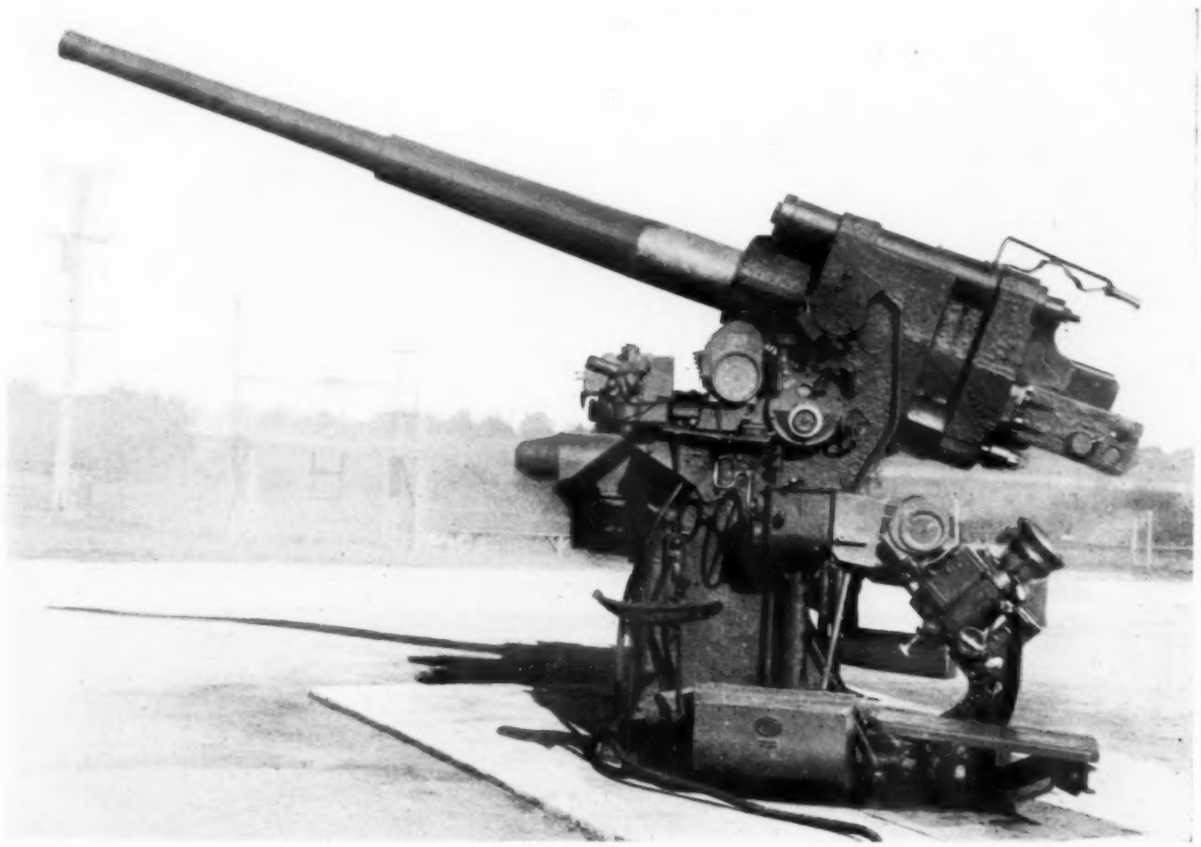
For use with the Infantry, two new weapons recently have been adopted by the War Department: a 37-mm. gun of greater power than the present service type, and a 75-mm. mortar to replace the inaccurate and short range Stokes trench mortar used during the World War.

A new 75-mm. pack howitzer has been adopted and the first battery of this matériel issued to the Field Artillery in the spring of 1927. This 75-mm. pack howitzer matériel culminates at least twenty years of effort on this design. This howitzer has a range of 9,000 yards, and replaces the old Vickers-Maxim 2.95-inch mountain gun of the Spanish-American War period, with its very inadequate range of approximately 4,000 yards.

The first battery of the new 75-mm. field guns was issued last fall to the School of Fire at Fort Sill, Oklahoma, where it is understood this new matériel will be used in one of the school batteries, and thereby subjected to very exhaustive firing and maneuvering tests. This new carriage is of the split trail type with a traverse of 56 degrees and a maximum range of 15,000 yards.

The 105-mm. howitzer is a new caliber in our Army, and consequently every possible effort was concentrated on the development of this new matériel. This 105-mm. howitzer matériel of the split trail type has a maximum range of 12,000 yards with a 33-pound projectile, and should prove a most effective companion piece for the 75-mm. gun for divisional artillery. This new matériel has been standardized recently, and the first units are being exhaustively tested both by the Field Artillery Board at Fort Bragg, North Carolina, and by the Aberdeen Proving Ground, Maryland, in order that any minor corrections in design may be made prior to the manufacture of additional batteries.

The new corps weapons are a 4.7-inch gun and a 155-mm. howitzer. The 4.7-inch gun, Model of 1921, has been extensively tested both by the Ordnance Department and by the Field Artillery Board for the past five years, and minor corrections made in a design which on the whole has proven highly satisfactory. This new 4.7-inch gun has a range of approximately 20,000 yards as compared with a range of less than 9,000 yards for our old 4.7-inch gun, Model 1906. The total weight of this new matériel of less than 6 tons makes it a highly mobile unit.



Another but older member of the antiaircraft gun family fostered by the Ordnance Department, U. S. A., the 3-inch Antiaircraft Gun, Model 1917, M II.

The first unit of the latest design of 155-mm. howitzer recently has been sent to the Aberdeen Proving Ground for test. This new howitzer, weighing approximately 8 tons, has a maximum range of over 16,000 yards; in other words, when compared with the 155-mm. G. P. F. gun used during the World War, this new corps howitzer has almost the range of the G. P. F. gun with only a little more than half of its weight.

The new army weapons are a 155-mm. gun with a range of 26,000 yards, and an 8-inch howitzer with a range of more than 18,000 yards, which can be mounted interchangeably on the same carriage. To increase the mobility of this matériel, the gun or howitzer is removed

from the carriage for traveling and carried on a separate transport wagon. This brings the weight of the carriage load to less than 20,000 pounds, so that this load can be hauled readily by the commercial 10-ton tractor. This new matériel has been tested thoroughly for several years, and with minor changes, found to be very satisfactory. It is planned to manufacture a second unit better to work out some of the manufacturing details before recommending this matériel as a new standard for adoption by the War Department.

It is thus seen that we now have for the divisional troops a complete new line of artillery matériel adopted by the War Department; and for the corps and army artillery very satisfactory new types, all of which are approaching standardization.

For the fixed harbor defense artillery, the 16-inch gun and the 16-inch howitzer matériel are our new standard equipment.

The post-war development of railway mounts calls for a large railway carriage mounting either the 14-inch gun or the 16-inch howitzer, and a smaller carriage to mount either the 12-inch howitzer or an 8-inch gun. The larger mount for the 14-inch gun has been developed, and the fourth of these new mounts is now nearing completion at the Watertown Arsenal. The smaller mount is now undergoing its final proof testing at the Aberdeen Proving Ground.

A large amount of splendid development work on new types of artillery matériel has been accomplished. Along with the development of types has been carried improvement in the processes of manufacture, the most outstanding of which is the autofrettage method of constructing cannon. All of the smaller calibers up to and including 6-inch have now been manufactured successfully by this new method. All drawings of recently adopted equipment have been prepared with a view to their use in quantity production manufacture. The Ordnance Department is now in the enviable position of being able to supply our army with artillery matériel second to none in case of an emergency.

THE most outstanding event affecting our ammunition problem during the past year was the recent passage by Congress of a bill which was signed by the President, appropriating and making available immediately $2,300,000 for the rehabilitation of the Picatinny Arsenal. In rebuilding the arsenal, there will be incorporated the most modern improvements that experience has shown to be advisable. When completed, in addition to serving as an arsenal where our experimental and development work on high explosives, loading, etc., may be conducted, and where a limited quantity of explosives and loaded ammunition may be produced, it will serve as a school, where in time of an emergency, our inspectors may be trained properly and where our contractors may learn how to make safe and efficient ammunition.

Nitrates are fast leaving the class of strategic war materials. It is believed that the domestic production of synthetic ammonia from atmospheric nitrogen shortly will render this country free from any shortage of nitrates, should we not have access to Chilean nitrate in time of an emergency.

Nitric acid, whether from Chilean nitrate, synthetic ammonia, or coke oven ammonia, will likely always remain a material the demand for which in time of war will increase many fold over peace-time requirements. The ammonia oxidation facilities at the U. S. Nitrate Plants for the manufacture of nitric acid, therefore, for the immediate future at least, constitute a reserve that must be held. It is believed to be only a question of time until commercial nitric acid manufacture will be placed on such a basis that the expansion of existing facilities may give quicker and more dependable nitric acid production than the war-time nitrate plants. It is considered desirable, however, that the facilities for the manufacture of ammonium nitrate at the Nitrate Plants be held pending development of the manufacture of commercial nitrates.

ALTHOUGH the work at Picatinny Arsenal was greatly handicapped by the limitations of the facilities available, a considerable number of experimental samples of FNH powder have been manufactured for ballistic tests in the entire series of weapons ranging from 37-mm. to 155-mm.

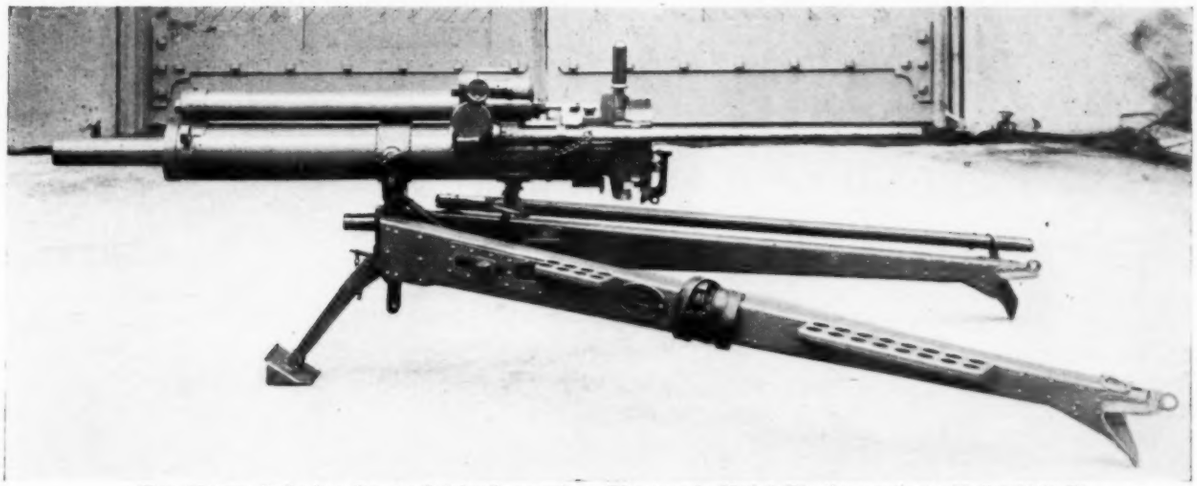
In addition to the FNH powder for the 75-mm. gun, Model 1897, and the NH powder (not flashless) for the 155-mm. G. P. F., both of which have been declared standard, the du Pont Company has produced satisfactory FNH powders for the 75-mm. pack howitzer, the 105-mm. howitzer, and the 2.95-inch mountain gun. Considerable progress has been made toward the development of satisfactory powders for the 75-mm. gun M1 and the 3-inch antiaircraft guns. Both Picatinny Arsenal and the du Pont Company are continuing their efforts further to improve a number of these powders and to develop suitable powders for other weapons. Each of these organizations works independently of the other and on compositions of different type.

The development of a flashless, non-hygroscopic powder has required a re-study of the ignition problem, since a number of the compositions which meet the requirements for non-hygroscopicity are more difficult to ignite than the present pyro powder. It was also found that the method of ignition exerts a great influence upon the flashless characteristics, probably fully as much as the composition of the powder itself. It is improbable that a satisfactory substitute for black powder for ignition will be developed in the near future. Black powder seems to have certain characteristics which make it suitable particularly for ignition purposes.

In addition to tests in connection with ignition, there have been under way at the Aberdeen Proving Ground many other projects involving basic research, such as effect of powder temperature on velocity and pressure, velocity and distribution of shell fragments, effect of moisture in powder on ballistics, etc. Much data of general and permanent value have been obtained.

TO facilitate the peace-time production of fuzes and to permit direct contact between experimental and production personnel, all fuzes are now being manufactured at the Picatinny Arsenal.

Base detonating fuzes for armor-piercing shell have recently been perfected and 12,000 of these have been tested and accepted for issue to the service.



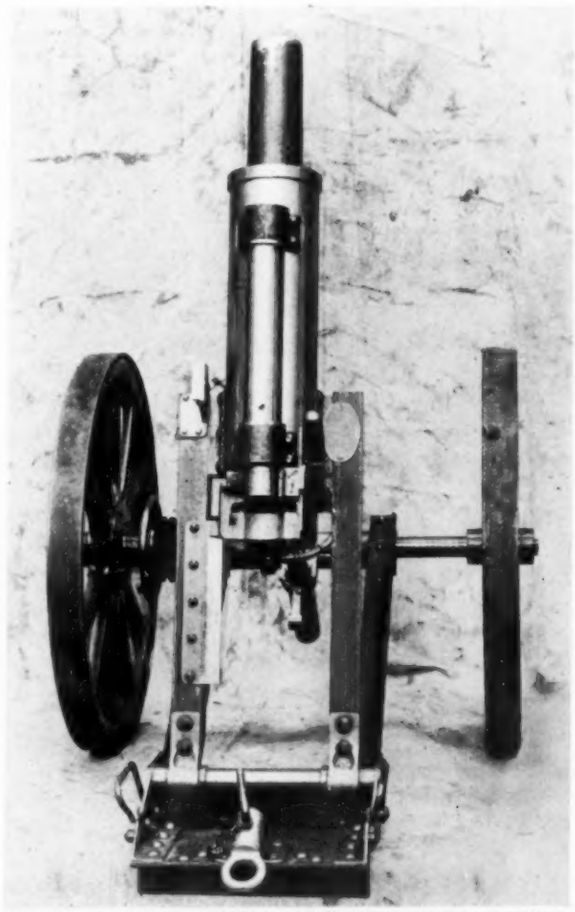
The 37-mm. Infantry Gun and tripod mount. The gun is Model T1, the carriage, Model 1925 E1.

Efforts are still being made to perfect a combination superquick short-delay fuze to replace the several types now in service. Of the many experimental projects connected with artillery ammunition this has been the most difficult. Nevertheless, recent tests have shown improvement in performance and we are not discouraged.

The early satisfactory production of boosters was one of the stumbling blocks in our war-time munitions program. To facilitate the manufacture of booster casings, several new methods of production have been investigated. Certain companies which made booster casings during the war have furnished, willingly and at considerable trouble and expense to themselves, valuable information. As a result of the study which has been going on, Frankford Arsenal, after a long period of experimentation accompanied by many discouragements, has now been given an order for the production of several thousand casings and it is hoped will soon be in a position to furnish full manufacturing information to the District Offices.

Due to difficulties in mass production, handling and shipping, the false ogive type of shell is being replaced wherever possible by the one-piece type.

Improved methods of production are still under investigation but it appears from the work accomplished to date that the conventional shell forging from pierced billets still holds its own.



The 75-mm. Infantry Mortar and Carriage, at 80° elevation, rear view.

It has been established that satisfactory shell can be produced from steel tubing. Whether such shell can be produced more rapidly than the forged shell has not yet been proved. This will be determined as soon as sufficient tube shell can be made. Since sufficient quantities of forged shell can eventually be obtained with certainty the use of any other type depends almost wholly upon the comparative rapidity of production.

In bomb construction it has been found possible to eliminate as separate parts the nose and tail castings and to make a one-piece bomb body without joints or seams except those necessary for the nose and tail fuze, and a small closing cap at the rear end.

Experimental designs of cylindrical type demolition bombs eventually to replace the present standard streamline demolition bombs have been completed on the 100-pound, 300-pound, 600-pound, 1,100-pound, and 4,000-pound sizes; the 2,000-pound size has already been standardized.

To improve the safety conditions in connection with fuzing, handling, storing, and the operation of our bomb fuzes, the development of new fuzes has been undertaken. The new fuzes are of the selective delay type. The detonators are out of line with the firing pin and primer until the fuzes have been armed after the bomb has been dropped a definite distance from the plane. Orders are being placed for a

considerable number under semi-production methods for service test.

While all the data obtained from the recent bombing tests in connection with the destruction of the Pee Dee River Bridge have not been received, compiled, and studied, information obtained by our own observers indicates that our adopted bomb development program has been and is being conducted along the proper lines. One of the most interesting and important results brought out by these tests is that we have learned the minimum size of bomb necessary to secure proper destructive effect on structures of this type.

EXPERIMENTAL work has continued actively on the development of loading ammunition. The density of boosters for bombs and shell has been standardized so as to facilitate production. The melting of TNT has been investigated and equipment has been developed to speed up this phase of shell and bomb loading.

In experiments with the explosive train apparatus, it has been ascertained that a certain definite minimum height of explosive is necessary to permit the rate of detonation to obtain a maximum; also that to transmit a detonation efficiently from a detonator to a booster it is unnecessary to have the axis of the connecting column of explosive in line with the axis of the detonator and booster. This knowledge will make the design of fuzes more flexible.

Drawings have been standardized for a landing flare, an improved wing tip flare, colored aviation and ground signals, and quantities of these pyrotechnics have been manufactured for service test and issue. Pyrotechnic dischargers have been manufactured and issued to the service for test. A design of a 600,000-candle power observation flare has been laid down and a preliminary sample is under manufacture.

The hand grenade used so extensively by the Infantry is no longer loaded with TNT but contains a very quick burning smokeless powder. By this change better fragmentation is obtained. The fulminate detonator of the firing mechanism has been eliminated and the complete grenade is now packed and issued as one unit with the firing mechanism in place.

A program for the balancing of our large stocks of existing components of ammunition has been inaugurated. Picatinny Arsenal has a program for loading these balanced stocks of components and is making definite progress on the actual plans for loading in case of an emergency the greater part of the first year's production of ammunition. Both Frankford and Picatinny Arsenals are completing descriptions of the manufacture of the major items of artillery ammunition, including the essential data necessary for concrete factory plans.

Attention has been concentrated on substitutes for strategic materials. Wherever possible, tin is being replaced by other materials. Fiber is being used in place of tin plate for containers for ammunition. Specifications have been drawn up for an asphaltum varnish for war-time use to replace shellac for the interior coating of shell.

An important contribution to industrial preparedness during the past year has been effected by establishing very satisfactory contacts with various industries. A conference held with the chemical manufacturers in one of the Districts was of great assistance in connection with the study of our problem of the emergency procurement of high explosives. Similar contacts have been made with the pyroxylin industry and the cotton purification industry. Manufacturers have shown a gratifying willingness to coöperate with the Ordnance Department in an endeavor to solve its many varied and complex problems.

DURING the past year, twenty of the new Pedersen caliber .276 semiautomatic rifles were completed by Springfield Armory and turned over to the Infantry and Cavalry Boards for service test.

Mr. Garand has also been instructed to design a .276 semiautomatic rifle and have it available for the competitive test to be held in the near future. This is one of the most important projects of the Ordnance Department. In view of the great number of designs which have been tested in the past and the amount of time which has been consumed in arriving at a decision on this matter, it has been decided to hold a competitive test on a date to be announced later in order that all inventors and manufacturers may have an opportunity to submit their weapons to the Ordnance Department for competitive tests. The Ordnance Department will submit an improved Garand type and a Pedersen type for competitive test with the weapons designed and furnished by inventors and manufacturers.

The War Department will be requested to appoint a board of officers for the purpose of supervising the test. As a result of the semiautomatic rifle development, it is believed we will obtain a suitable design for a receiver sight to be used not only on the semiautomatic rifle but which also may be applied to the Springfield rifle in case it is so desired.

To reduce the number of unserviceable rifles on hand, the production of caliber .30 barrels at Springfield Armory has been increased twice during the past year so that the present production is 225 barrels per day. Springfield Armory is also overhauling 80 rifles per day in addition to the manufacture of spare parts.

Extensive experiments are being made on caliber .50 machine guns in an endeavor to increase their efficiency and improve their use for antiaircraft work. New flash hiders were designed for the caliber .30 and caliber .50 machine guns and gave satisfactory functioning during the antiaircraft exercises.

A new type of aircraft machine gun which can be used both as a fixed and flexible gun, with right or left hand feed, and having many other improvements over the Model 1919 type has been developed and furnished the Air Corps for test.

New cover catches were designed for the machine guns and new water pumps were furnished for the antiaircraft firings.

Springfield Armory is also manufacturing 2,000 pistol barrels made of rustless steel, and is applying this material wherever practicable to parts of the Browning automatic rifle gas cylinder to reduce corrosion.

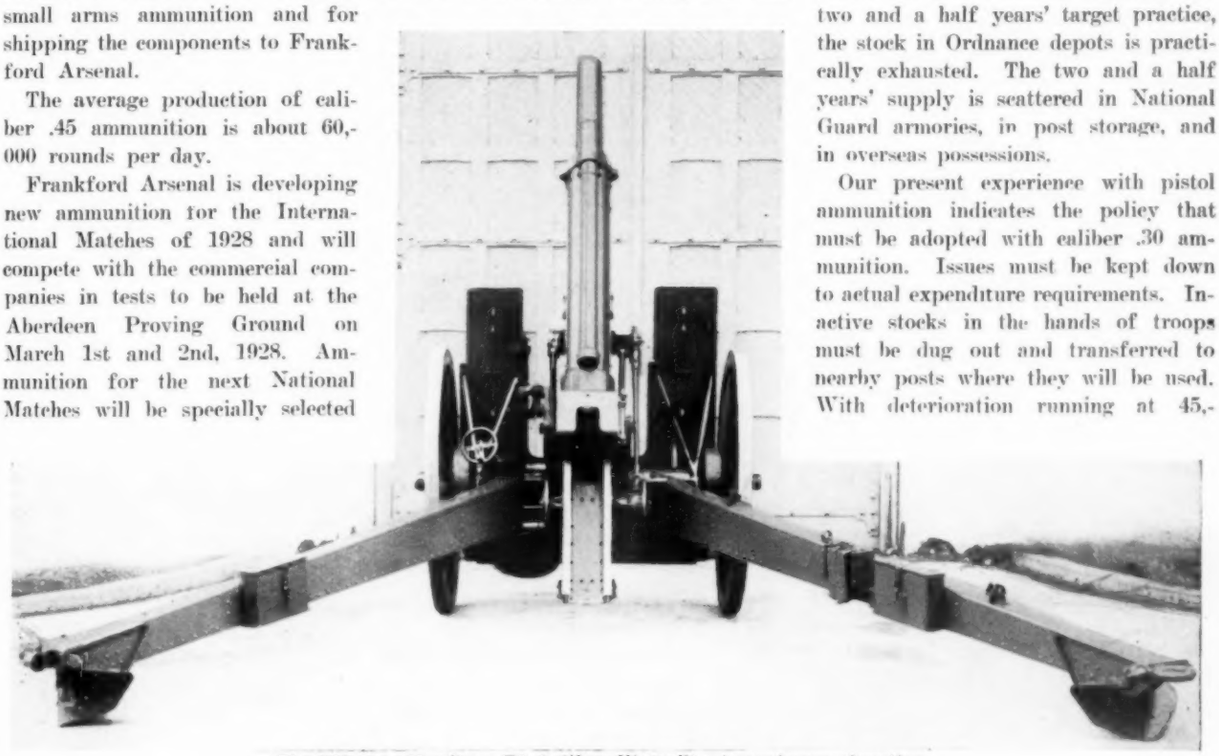
All orders for caliber .22 M1 rifles are about completed at Springfield Armory.

During the past year Frankford Arsenal has operated at its economical capacity of 60,000,000 rounds of caliber .30 ammunition per year. Nineteen million rounds have been completed for the Navy and Marine Corps. In addition orders have been placed through competitive bidding with the Remington Arms Company for 10,000,000 rounds; Peters Cartridge Company 12,000,000 rounds; Winchester Repeating Arms Company, 9,600,000 rounds; and Western Cartridge Company 1,500,000 rounds.

Funds have been provided to Benicia Arsenal and San Antonio Arsenal for the breaking down of unserviceable small arms ammunition and for shipping the components to Frankford Arsenal.

The average production of caliber .45 ammunition is about 60,000 rounds per day.

Frankford Arsenal is developing new ammunition for the International Matches of 1928 and will compete with the commercial companies in tests to be held at the Aberdeen Proving Ground on March 1st and 2nd, 1928. Ammunition for the next National Matches will be specially selected caliber .30 M1 ammunition and all the commercial companies will be given an opportunity to compete with Frankford Arsenal for the supply of this ammunition.



The 105-mm. Howitzer T2 (with split trail) at maximum elevation.

Extensive experiments are being made with the caliber .50 ammunition to improve its functioning.

A very important step has been taken in connection with the procurement of caliber .22 ammunition during the past year. The development of the non-corrosive primer for this type of ammunition has been so successful that the Ordnance Department has abandoned the purchase of the old type of ammunition and has recently placed orders for about 30,000,000 rounds of the new type. This ammunition has the great advantage of equaling the old ammunition in accuracy and functioning not only, but does not corrode the bore after firing. This does not mean that less care of the rifles can be taken but does mean that in case a rifle is not cleaned immediately after firing it will not rust.

Extensive development of a non-corrosive primer for the caliber .30 cartridge is also under way but this has been found to be a little more difficult problem and at the present time we are not ready to make a change in our service primer. However, we have manufactured 100,000 rounds of the new type at Frankford Arsenal and have shipped 10,000 rounds to each of our tropical stations for surveillance storage.

Experiments are also being made to apply a non-corrosive primer to our caliber .45 pistol ammunition.

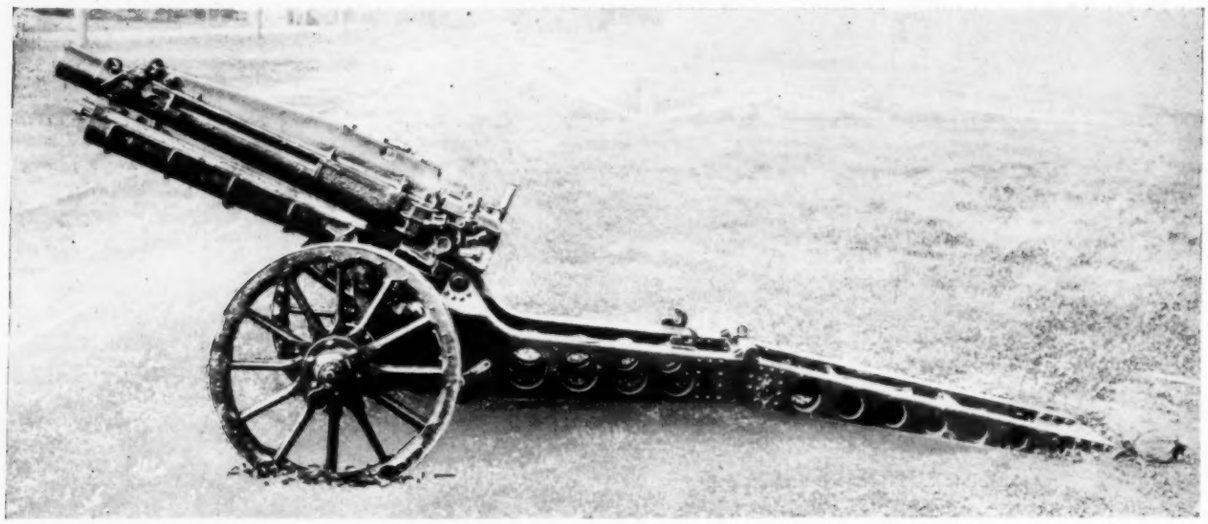
THERE are problems of supply and distribution which become increasingly important with the growing deterioration of our war stocks of ammunition. Take for instance the caliber .45 pistol ammunition manufactured during the war. While there is on hand sufficient for two and a half years' target practice, the stock in Ordnance depots is practically exhausted. The two and a half years' supply is scattered in National Guard armories, in post storage, and in overseas possessions.

Our present experience with pistol ammunition indicates the policy that must be adopted with caliber .30 ammunition. Issues must be kept down to actual expenditure requirements. Inactive stocks in the hands of troops must be dug out and transferred to nearby posts where they will be used. With deterioration running at 45,000,000 rounds a year, economy of transportation demands great care in preventing shipping out of depots ammunition which will shortly have to be shipped back for breaking down.

Small arms ammunition of an unserviceable grade is being broken down at Frankford, Benicia, San Antonio, and the Philippines. The resulting scrap is shipped to Frankford to be used in the manufacture of new ammunition. The average cost of breaking down is 91 cents per thousand rounds. The resulting scrap is worth $4.89.

THE Ordnance Department is charged with the maintenance of matériel in the hands of troops, the preservation of matériel in storage, the inspection and repair of this matériel, the application of needed modifications, the publication of technical information relating to these functions, and with the directive control of the securing of spare parts and cleaning and preserving materials.

Complete knowledge as to the proper and economical functioning of complicated mechanisms, such as guns and their carriages and other ordnance, can only be obtained by continual operation under service conditions. Occa-



The 75-mm. Pack Howitzer in firing position with rear trail seated.

sionally faults are developed which are serious in their nature. Energetic measures are taken to correct such faults at once. Reports of a minor nature having to do with suggested improvements affecting more economical operation and maintenance are permitted to accumulate until a sufficient number are at hand to warrant changes in drawings and distribution of Modification Work Orders for a given class of matériel. During the past year seventeen Modification Work Orders have been issued, special precautions being taken to prevent unnecessary expenditures on obsolescent matériel.

To facilitate instruction of personnel and to help standardize methods of inspection, repair and overhaul, "Technical Regulations" are published for the use of Ordnance Maintenance Companies and the personnel connected with Post Ordnance Shops. In addition information of general application not previously published is disseminated through the medium of Field Service Bulletins.

An adequate supply of spare parts is essential if matériel is to be promptly repaired and maintained in an operating condition, and at the same time undue wastage must be prevented. The application of an "exchange system" aided by the repair and inspection facilities provided in the Ordnance Maintenance Companies and Post Shops, has proven extremely satisfactory. The supply of spare parts has been in general adequate and hoarding has been practically eliminated. It is felt that the economies effected have been outstanding.

For the proper lubrication and preservation of Ordnance large quantities of cleaning and preserving materials are required. In the past inferior materials have been issued, the distribution has not been all that could be desired, and much waste has occurred. Under the system of distribution which has been in operation little more than a year, expenditures have been reduced, supplies have been more than abundant, and the quality generally satisfactory. Further reduction in issues is possible and a revision of existing regulations affecting this matter is under way.

Vast quantities of Ordnance matériel are in storage at widely scattered stations with varying facilities. In accordance with the requirements under which money is appropriated, matériel included in the reserve of two armies is cared for as far as possible, while matériel in excess of this quantity receives but little attention. It is probably good economy not to expend money upon much of it, but it is questionable economy to retain this deteriorating matériel beyond the stage when it can be economically overhauled and restored to service condition. In this connection a recent decision has been published whereby the obsolescent 5-ton artillery tractor will be scrapped when the unit cost of overhaul approximates one thousand dollars. As individual expenditures of more than fifteen hundred dollars were of frequent occurrence in the past, a decided curtailment of expenditures is certain to result. The storage problem deserving most attention at this time is believed to be the development of a satisfactory manner of storing hydropneumatic mechanisms of the Puteaux and Filloux types. For economy in peace-time operation, overhaul work on this matériel has been concentrated at Rock Island Arsenal.

Matériel in the hands of troops is maintained as a responsibility of the Corps Area and Department Commanders. The Corps Area Ordnance Officer, as a staff officer of the Corps or Department, is directly responsible for the maintenance of matériel under his jurisdiction. The maintenance is effected through the medium of *orders*, inspections, and repair organizations. More permanent buildings are needed, but, nevertheless, it can be stated that all of the large posts are now provided with well equipped shops, employing a nucleus of skilled civilian employees and manned by enlisted personnel of Ordnance Maintenance Companies. Maintenance of matériel in the hands of troops has shown improvement during the past year. Marked progress is being shown in standardization of methods of inspection and repair, all tending toward the aim of obtaining the most for the money expended. The proper functioning of matériel in the hands of troops is a standard by which the line gauges the efficiency of the Ordnance Department. Appreciation of this fact has lead to progressive effort which has been productive of increasingly satisfactory

results. The ultimate may never be attained but the effort will be unceasing.

WAR PLANNING in the Ordnance Department received its impetus, in 1919, from a board of officers, since called the "Munitions Board," which outlined and recommended a munitions policy to be followed by the Department. The reports of this board, twenty-four in all, cover the field of our major items of issue and constitute one of the most constructive steps in our history of war planning.

Until 1924 war planning in the Department was confined almost entirely to the procurement and personnel plans.

In 1924 a war planning section was established in the general office to supervise and coördinate the activities of the war planning sections of the major divisions of the Ordnance Office. The chief functions of this section are to determine the total requirements under any War Department mobilization plan and to outline the mission of the divisions of the Ordnance Office under these plans.

In 1926 there was constituted a War Plans Committee, consisting of the Chief of Ordnance and the chiefs of the major divisions of the office, whose function is to consider reports of progress, recommendations from any source and recommend policies to the Chief of Ordnance. This committee has proved very useful in clearing up many obscure or controversial questions and as a result it has been possible to issue clearer and more definite directions to the operating divisions.

During the past two years Ordnance procurement and supply plans have proceeded on the bases established by the War Department General Mobilization Plan of 1924.

For the past five months the War Plans Section has been working on the War Department Supply Estimate. This is a proposed mobilization plan against the requirements of which actual stocks and expected production are being balanced and reported to the War Department. It is expected that after consideration by the War Department of the availability of supplies, there will be evolved a mobilization plan which will have given due consideration to the supply features of the plan.

A reapportionment of items on the requirement list to the Arsenals and Districts has been made during the past year to meet the requirements of the 1924 General Mobilization Plan. This did not involve a complete change in the procurement plans, as, due to the apportionment previously made on the 1922 and 1923 plans, it was only necessary to change the quantities or rates of production involved for some items. However, advantage was taken of the information previously obtained to place apportionments to better advantage wherever possible, especially with a view to a more equitable distribution of the Ordnance load throughout the country.

The policy for placing apportionments for gages has been determined and apportionments have been made for gages for twenty items.

The only item of new matériel which has entered the war plans so far is the 75-mm. M1 gun. Decision has been made to produce the old model gun at the Arsenals and to begin production with the new model at commercial establishments.

The meeting of the District Chiefs was held in the Ordnance Office on October 4th and 5th, 1927, attended by the chiefs of ten districts (Baltimore, Birmingham, Bridgeport, Buffalo, Cincinnati, Detroit, New York, Philadelphia, Pittsburgh, and St. Louis), Assistant District Chief of one District (St. Louis), and the Advisory Board of the Birmingham District.

There are now thirty-four officers devoting their full time and one officer devoting half time to the procurement planning work, an increase of twelve full time officers during the year. They are distributed as follows: Ordnance Office, 10; manufacturing arsenals, 5; procurement districts, 15; industrial plants, 4.

There are fourteen civilian District Chiefs, twelve civilian Assistant District Chiefs, and one hundred and thirty-three civilian members of the various District Advisory Boards. The Advisory Board of the Birmingham District is the only one which has been formed during the past year.

The Ordnance Committee of the Army and Navy Munitions Board has made an apportionment of Navy requirements, which was sent to the Ordnance procurement districts during the past year. This apportionment has been studied by all district offices to avoid possibility of conflict with the Navy.

The possibility of utilizing seamless tubing in place of gun forgings is also being studied.

The Ordnance Department, in conjunction with the Corps of Engineers, is making a survey of the machine tool capacity of the country for the War Department. This work was started during the past year and it is not believed that it will be completed before the end of next year.

During the year 1927 the Specification Unit of the Ordnance Department issued 26 new specifications in addition to 14 revisions of then existing specifications. Since the Specification Unit was established 596 specifications have been issued in the form prescribed by Army Regulations 850-25. In addition there are 630 more specifications which could be used in the event of an emergency but these have not as yet been reëdited in accordance with the latest practice in writing specifications.

The increasing interest of the engineers and executives of industry in our endeavor to plan for war is very gratifying. It is plainly evidenced in the growing support being given to the Army Ordnance Association.

It has not been possible in this paper to cover all the activities of the Ordnance Department. In fact I have had to leave out many that I would like to have discussed. But let me say in closing that the Ordnance Department is an organization in which I take great, and, I hope, justifiable, pride; its achievements and successes always give me pleasure. I appreciate particularly the high quality of Ordnance personnel, both military and civilian, and the fine component of our citizens of American industry and especially the Army Ordnance Association. I desire to acknowledge the loyalty and sustained effort all have given to Ordnance problems.

Let me again define Ordnance responsibilities in four words: *Design, procurement, supply, maintenance.* No one of these is more important than any other and unless we can be efficient in all, the good name of the Ordnance Department must suffer.

Tracer Ammunition

Part I: Loading and Assembly Operations

Capt. S. P. Meek,* Ord. Dept., U. S. A.

THE components entering into a completed round of tracer ammunition are the cartridge case, the primer, the propellent charge and the tracer bullet, which latter is filled with tracing mixture and igniter.

The cartridge case is manufactured in the same way as the cartridge case for a round of ball ammunition. The cartridge brass is fed in the form of strips into a double action press, where a blank is cut and cupped as the first stage of manufacture. This cup passes through a long series of operations consisting of draws, anneals, washes, trims and forming operations, as a result of which it becomes a caliber .30 cartridge case. It is now ready for use in loading ball ammunition, but before being used for tracer, it goes through one additional process, namely, case blackening. The cartridge case is put in a revolving cylinder and held in a tank of solution at a boiling point until the case becomes black. The solution used has the following composition: 70 gals. water, 36 lbs. hyposulphite of soda, 9 lbs. lead acetate. The case is rinsed and dried and is ready for priming.

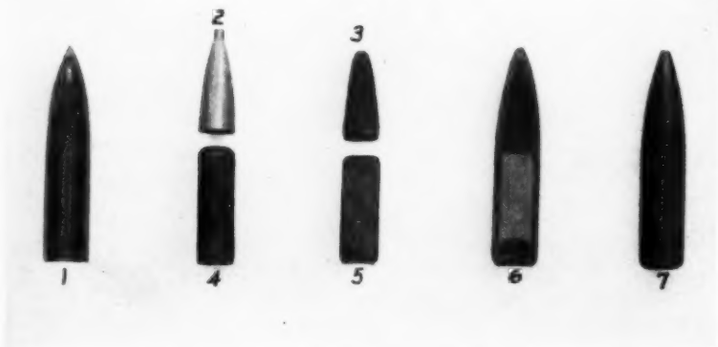


Fig. 1. The Caliber .30 Tracer Bullet.

1. Jacket, sectionalized; 2. Head slug before assembly; 3. Head slug after assembly; 4. Container before assembly; 5. Container after assembly and loading; 6. Completed bullet, sectionalized; 7. Completed bullet ready for loading into cartridge case.

The manufacture of the priming mixture, while to a certain extent allied to tracer mixture manufacture, is carried out in a separate building. The primer material is mixed and sent to the loading shop where a measured quantity is pressed into a previously formed primer cup by a hand press. A piece of foil or paper is pressed on top of the primer mixture and the anvil is inserted. The primers are dried in a Gordon dryer and are then ready for use.

In priming a cartridge case for use for tracer ammunition, the primer, after inserting, is varnished in with colored shellac or lacquer. This is an operation common to all cartridge cases, but usually the excess shellac is wiped off. This is not done in tracer cases, however, the excess shellac remaining on the head of the case. The shellac used is either red or green, depending upon the color of the tracer cartridge and the color used on the primer corresponds to the color of trace of the bullet with which the case is loaded.

The manufacture of a tracer bullet is, according to present practice, a comparatively simple operation. The bullet jacket is first formed roughly but not pointed on one set of machines. The lead slug is formed by swedging and the container is drawn and trimmed to finish size. The three components are then fed into a straight line bullet machine which points and finishes the jacket, inserts the lead slug and container, and completes the assembly of the bullet, with the exception of the tracer mixture, on the one machine.

THE assembled tracer bullets are sent to the tracer loading tables ready for charging with tracer mixture. The tools used in loading tracer mixture into the bullets are shown in Fig. 4. They consist of (1) assembly block, (2) bottom die, (3) top die, (4) funnel, (5) cup, (6) mixture scoop, (7) igniter scoop, (8) loading press.

The uses of these tools is self evident from an examination of the figure referred to. The assembly block is merely a holder for the bottom dies which in turn are merely forms to hold a bullet during the charging operation. The top die and funnel are elongations of the bullet designed to enable the mixture to be put more readily into the mixture cavity. The cup holds the bulk mixture and igniter which are removed from it by means of the measuring scoop.

The press used is a Bliss Press designed for this purpose. It compresses the charge of four bullets at one time and consists essentially of an eccentric motion by which heavy lead counter-weights are raised, throwing the pressure upon the bullet. The use of each of these tools will be better understood when the process of loading is described.

The tracer-loading unit consists of eight machine operators. The duties of these operators are classed as follows: 1 top die cleaner, 1 block assembler, 1 bullet ejector, 1 press operator, 1 igniter charger, 2 mixture chargers, 1 sub-igniter charger. (When the sub-igniter system of loading is not being used, the sub-igniter charger is used as an additional mixture charger.)

When ready to start loading tracer bullets, the block assembler places bottom dies in the assembly block and puts a tracer bullet ready for charging in each die. The top dies and funnels are put in place and the various other operators place tracer mixture and igniter, and sub-

*Formerly in charge of Tracer Ammunition Development, Frankford Arsenal, Philadelphia, Pa.

igniter if used, into each bullet. The complete block is passed to the press operator who places it under his press and trips a lever so that the next revolution of the press will lower a loading punch onto the mixture and igniter and press them firmly into the bullet. After pressing the block is removed from the press and the loaded bullets ejected. The empty block is passed on to the block assembler who repeats the first operation. Thus it can be seen that although most of the steps are hand operations, the process is a continual one with little waste motion. The top die cleaner cleans the dies as needed by means of a power driven brush.

A number of experiments have been performed at the Frankford Arsenal to determine the limits of size that can be used on bottom dies and the correct diameter of bullet jackets. It is not necessary to go into this question in detail, but the reports indicate that the diameters of the bullets may vary within comparatively wide limits.

ALL bottles of tracer mixture and igniter have been thoroughly blended and are theoretically of uniform density. It has been found in practice that various lots will have a very slight difference in packing powder. The atmospheric conditions also seem to have some effect upon this property of the mixture. As a result, before loading can be extensively undertaken on any given day, it is necessary to test out the scoops used. If the bullets produced from the scoops are satisfactory, loading proceeds. If not, the size of scoops is adjusted by the foreman to give a satisfactory bullet. If the scoop is too small the bullet resulting is a "Low"; i. e., one in which the top of the mixture column is below a predetermined standard.

Fig. 3. Caliber .30 Tracer Bullet Loading Unit.
1. Top die cleaner; 2. Block assembler; 3. Bullet ejector; 4. Press operator; 5. Foreman; 6. Igniter charger; 7. Sub-igniter charger; 8. Mixture charger; 9. Mixture charger.

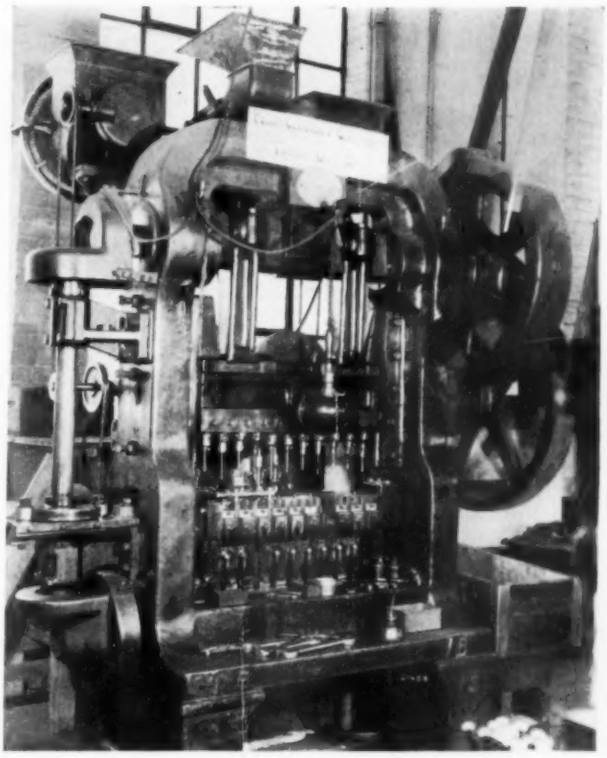


Fig. 2. Straight Line Bullet Machine.
Points jackets, assembles jacket lead slug and container, and compresses bullet.

If the mixture scoop is too large, the result is a "High"; i. e., a bullet in which the top of the mixture column is above the predetermined standard. Both of these classes of bullets will give functioning inferior to the normal bullet and consequently the scoops are kept adjusted to secure the maximum number of correct height bullets so as to keep manufacturing scrap at a minimum.

The shape of the punches used in compressing the tracer mixture has been subject to a rather extensive investigation. A large number of different styles and shapes of punches have been tried and the present one has been adopted as a result of these tests. This punch gives a very large exposed surface of igniter on which ignition may start and gives an exceptionally long plane of union between the igniter and mixture, thus facilitating the relay of the flame from the igniter to the mixture. These punches are made of tool steel and have a very long life. The punches are regularly checked by the foreman by means of a profile gage but are usually discarded long before any wear is shown by this method of gaging. The determining points of wear are first the rounding of corners. The punch as made has sharp corners and when these round off the punch is discarded. A second wear limit is when the punch gets rough and has a tendency to "pick up" igniter. By "pick up," I mean the tendency of the igniter material to adhere to the punch rather than to the bullet. The result of such a condition is that the igniting material lifts off the bullet instead of remaining in place.

The loading pressure used in charging the bullets with tracer mixture and igniter is rather high. This pressure may vary within wide limits, as low a pressure as

20,000 lbs. per square inch has been experimentally used and pressures as high as 80,000 lbs. per square inch have been experimented with. Too high a pressure may cause deformation of the bullets with a consequent disproportionate amount of manufacturing scrap while too low a pressure may give either a short trace or some other form of malfunction.

The loading pressure is calculated by a simple lever formula:

$$P=1' \ W/1'' \ a$$

where P equals the loading pressure in pounds per square inch, 1′ equals the distance from the fulcrum to the center of gravity of the counter-weights, W equals the weight of the counter-weights in pounds, 1″ equals the distance from the fulcrum to the center of the punch and a equals the area of the punch. In calculating from this formula for a change of the loading pressure, W, 1″, and a are fixed and the result that the formula may be written in simpler form P=K 1′, where K is a constant equalling W divided by 1″ times a, thus to vary the loading pressure it is only necessary to vary the lever arm of the counter-weights, lengthening this arm increasing the loading pressure, and shortening the arm decreasing the loading pressure.

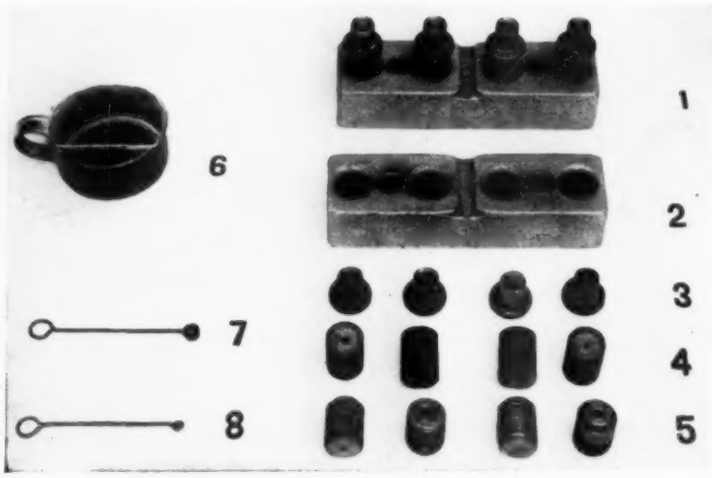


Fig. 4. Loading Tools, Caliber .30 Tracer Bullet.

1. Block assembly, complete; 2. Loading block with bottom dies in place; 3. Funnels; 4. Top dies; 5. Bottom dies; 6. Mixture cup; 7. Tracer mixture scoop; 8. Igniter scoop.

AFTER the bullets come from the loading press, they are given a process inspection to eliminate the following defects: highs, lows, and split bases. The peculiar type of malfunctioning caused by each of these defects will be given in detail later. After this inspection the bullets go to the basing machine. In the basing machine the portion of the jacet extending above the container is coned or crimped over slightly. The measure of the basing is taken from a profile of the jacket and as light basing is used as is practicable. The only object of this basing is to hold the container in place and prevent its flying out of the bullet in flight. The coefficient of sliding friction between two smooth gilding metal surfaces is not sufficiently high to insure the components of the bullet remaining together unless some basing is done.

After basing, the bullets are again inspected for defects and are placed in hermetically sealed containers. An aliquot portion of these bullets is withdrawn, assembled into complete rounds and given a functioning test. If this test is satisfactory, the bullets are released to the loading room.

The loading is done by machine, the primed cases, propellent charge and bullet being assembled into complete rounds. From the loading room the ammunition is sent to the inspection department where each round is put through an automatic gaging machine which rejects all cartridges which are off in any dimension. They are also given a final visual inspection for the elimination of such defects as scaly metal, deep dents and scratches.

After the bullets have been completely gaged and inspected they are boxed in cartons holding 20 rounds and each carton is labeled showing not only the type of ammunition, but also the operators and inspectors who handled each of the operations. A portion is then taken out for the final acceptance test which will be described in detail later. If the ammunition passes the final acceptance test, it is packed in wooden boxes with an hermetically sealed terne plate liner. The wooden box is stamped or stenciled with the type of ammunition and certain identification marks which in a case of tracer ammunition consist of a yellow band superimposed upon a green band and turned into stores for issuance to the using services.

(Part II of this article will be published in the May-June issue of ARMY ORDNANCE.)

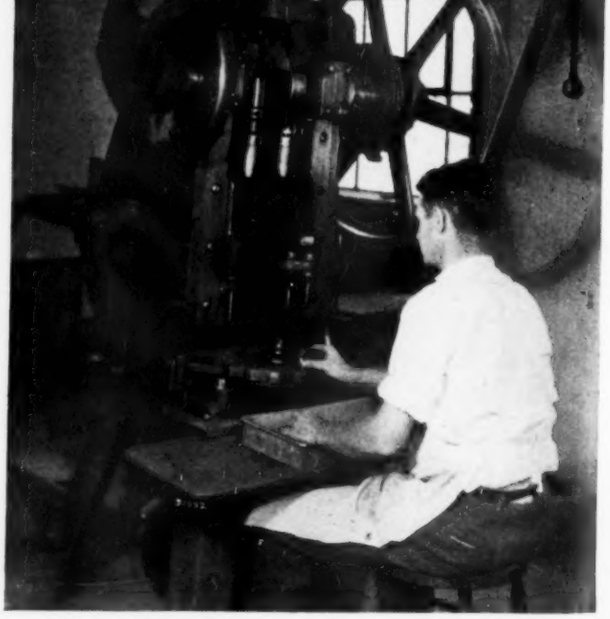
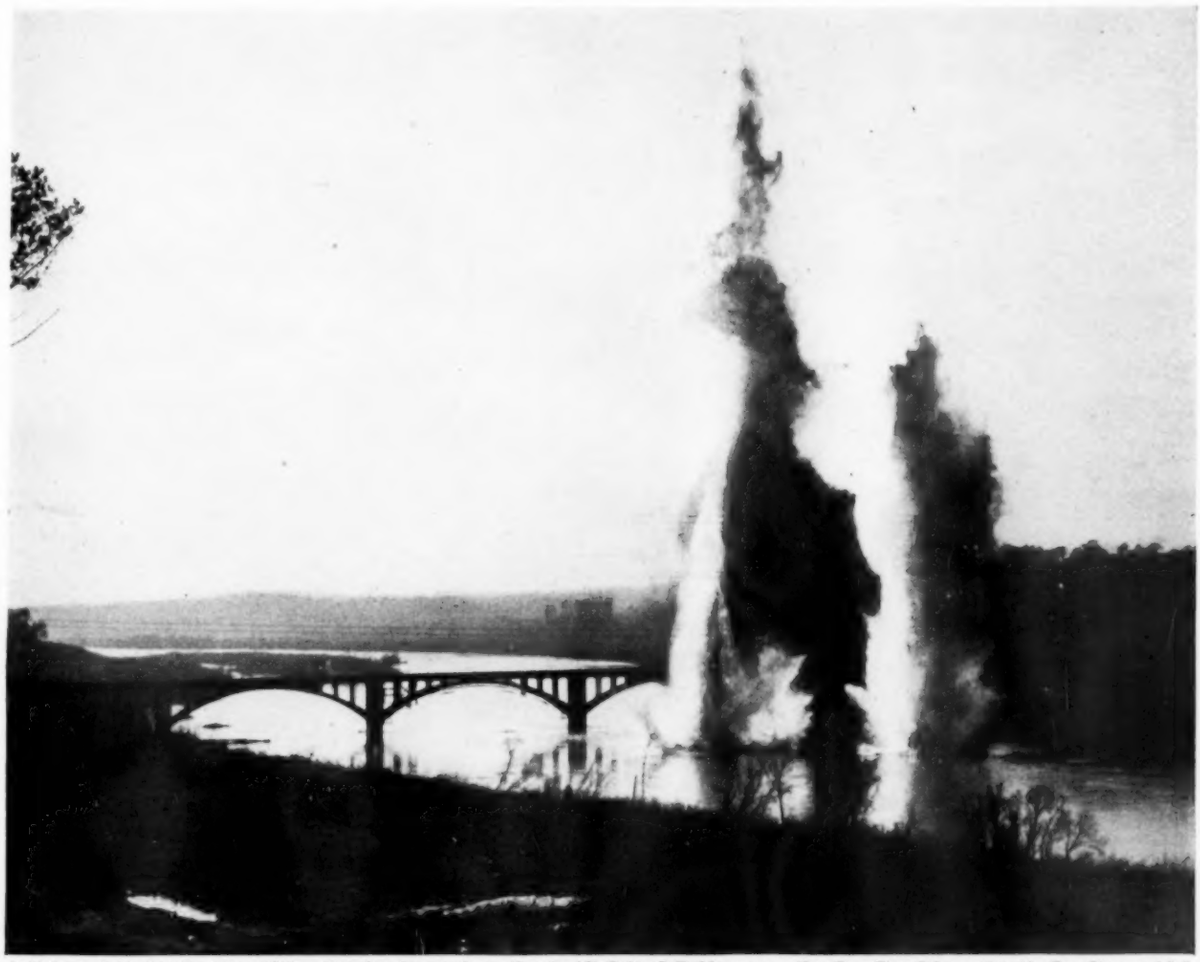


Fig. 5. Basing Operation, Caliber .30 Tracer Bullets.



A Salvo of 12 300-lb. Demolition Bombs dropped on the Swift Island Bridge over the Pee Dee River, North Carolina, which recently was offered the War Department for bombing tests.

Bombs Prove Their Effectiveness

Pee Dee River Bridge Tests Furnish Valuable Data

THE recent bombing of the Pee Dee River Bridge in North Carolina by the Army served to emphasize the effectiveness of high explosives in the destruction of such permanent installations as bridges, roads, and arteries of traffic. Several years ago there was constructed across the Pee Dee River a bridge built of reinforced concrete embodying the very latest ideas on this type of construction. This bridge was built to withstand the severest strains and stresses to which construction of this type could be subjected. It was 20 feet in width and approximately 1,000 feet in length and consisted of three huge spans across the river and seven smaller approach spans on each side.

Seven years after the completion of this structure, modern demands for the creation of a source of power made it necessary to erect a dam on the Pee Dee River south of this bridge at a height which would have resulted in the submerging of the bridge in the lake which was to be created. This necessitated the building of another bridge north of the first one, and at a greater height in order that traffic across the newly made lake might not be interrupted.

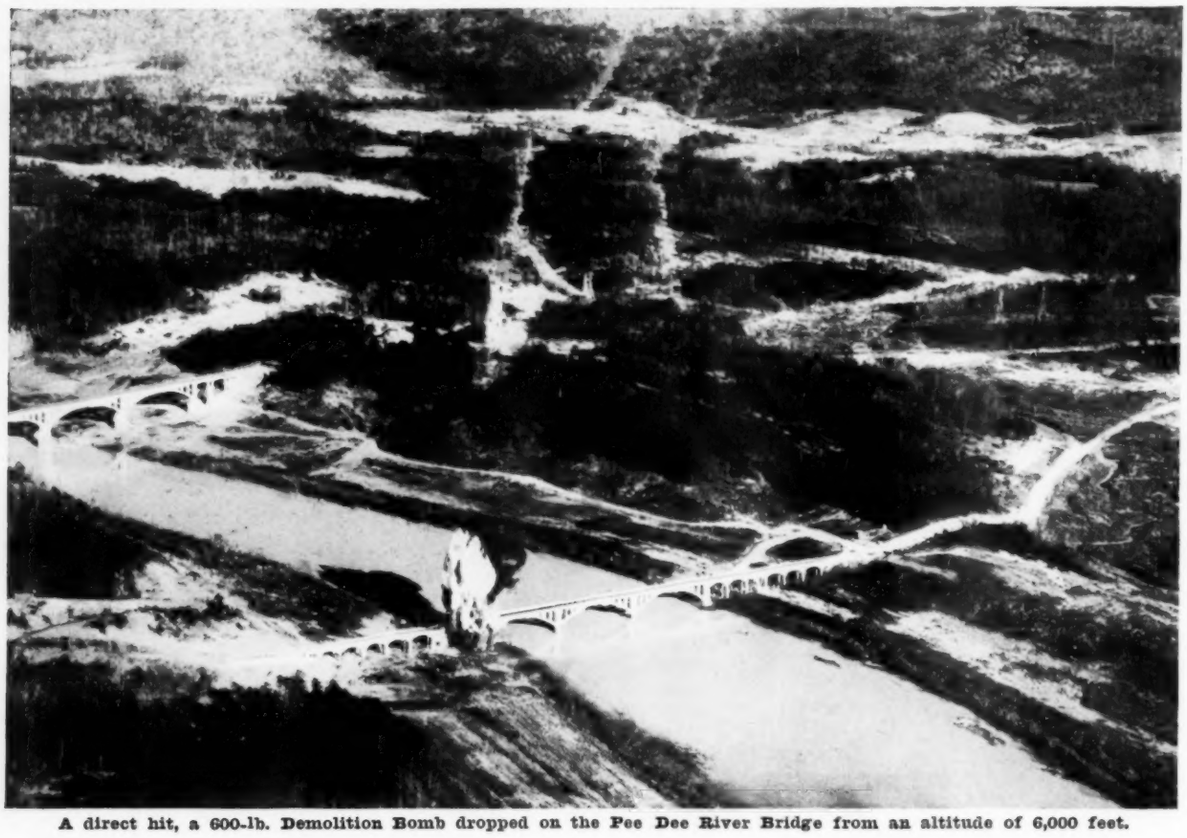
THE State Highway Commission of the State of North Carolina was directed to destroy the first bridge in order that it might not be a menace to navigation in the lake, and the Commission therefore asked the War Department if the opportunity to destroy this bridge would afford the Department the means of securing data which might be of military value. The War Department accepted this opportunity immediately, and the mission of destroying the bridge was turned over to the Air Corps the Engineer Corps and the Field Artillery. The War Department was anxious to determine:

1. Whether the present demolition bomb cases would stand up under impact from high altitude on reinforced concrete construction.

2. Whether the 300 pound, the 600 pound, or the 1,110-pound demolition bomb was the proper projectile to demolish such modern construction.

3. Whether to accomplish such destruction the bombs should be fuzed with detonators to give (a) instantaneous explosion, or (b) delayed explosion.

To determine whether or not aërial bombs would frac-



A direct hit, a 600-lb. Demolition Bomb dropped on the Pee Dee River Bridge from an altitude of 6,000 feet.

ture as a result of impact on reinforced concrete from normal bombing altitudes it was necessary to fill empty bomb cases with sand and then to secure hits upon the bridge with these bombs when dropped from airplanes. If an operation such as this was conducted during times of actual hostilities these bombs would have been dropped in salvo from airplanes flying in the usual offensive and defensive formation—about nine planes.

With such a formation it would not be very difficult to place the center of impact of the salvo on the bridge insuring a hit by at least one or two bombs. This method of procedure, however, was not possible during the Pee Dee River test in view of the fact that it would have entailed a certain hazard to occupants of the country adjacent to the bridge. For that reason it was necessary to carry out the tests with single airplanes or with a formation of not more than three airplanes. This greatly decreased the possibility of actually hitting the bridge.

THE minuteness of this target as seen from the altitude of the bombing airplanes can well be visualized when it is appreciated that it looked from a bombing altitude similar to a piece of white shoe string six inches in length. The speed of the plane from which the bomb is released is such that it crosses the bridge in one-tenth of a second. This means that there is only one spot in the air at which a bomb can be released to hit this target, and that an error of one-tenth of a second in this release would result in a complete miss.

Considering this it can be realized that the Army Air Corps had a difficult mission. As a matter of fact it could do exceptionally marvelous bombing from an accuracy point of view, and still not make a direct hit with a single bomb, just as an expert rifleman might hit a bulls eye 90 times of 100 shots and never actually hit a tack in the middle of such bulls eye.

To accomplish the purposes desired a certain number of sand-loaded bombs and demolition bombs varying in weight from 300 to 1,100 pounds, inclusive, were turned over by the Ordnance Department to the Air Corps. To drop this number of bombs required about 300 hours of actual flying. In other words it was necessary for Air Corps pilots and bombers to remain in the air this period of time in order to carry out these tests.

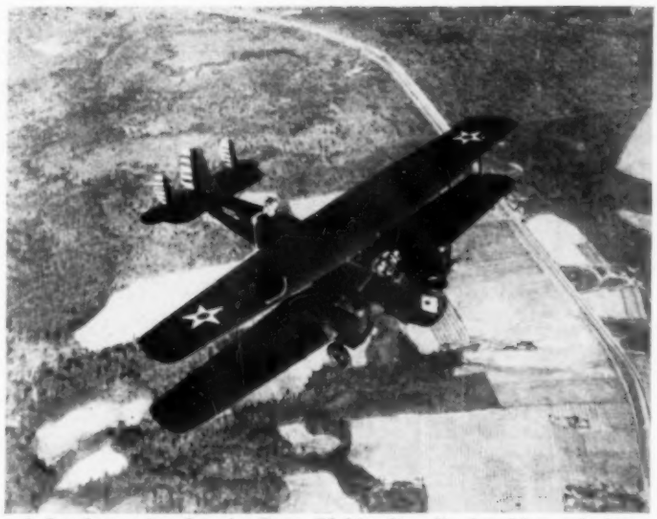
This mission was given the Second Bombardment Group of the Army Air Corps located at Langley Field, Va., a distance of 250 miles from the Pee Dee River Bridge, the commanding officer of which organization selected Pope Field, Ft. Bragg, N. C., located 62 miles from the Pee Dee River as a base for his operations against the bridge.

The number of miles flown by the bombardment airplanes during this mission totaled approximately 25,000 or a distance equivalent to a flight around the world. There were carried in these planes at different times demolition bombs totaling 61,800 pounds in weight. This amount of flying and this quantity of explosives carried was accomplished without injury or casualty, and without any motor failure or airplane trouble.

The tests commenced on December 19, 1927. The first three days were devoted entirely to the dropping of sand-loaded bombs, and the operations were carried on in extremely cold weather and in a gale which seldom decreased in velocity below 60 miles an hour at the flying altitude. The conditions, therefore, under which this flying was un-

dertaken were anything but propitious. The sky was devoid of cloud formations, and, therefore, permitted attaining the altitude necessary for the bombing, namely 6,000 and 8,000 feet.

After this phase of the tests was completed it was then desired to know what destructive effect could be accomplished with the 300-, the 600- and the 1,100-pound bombs. Three-hundred-pound bombs were first dropped at the bridge to determine whether this type, either from direct contact or from hits nearby, would injure it. After one day of operations it was learned that a bomb of this size offered no serious menace to construction of this type of reinforced concrete bridge. The next morning, therefore, was devoted to the use of 600-pound bombs. While these bombs accomplished some damage when they made direct hits, it was soon obvious that they would not result in the demolition of the structure. It was also apparent that explosions of these bombs even as close as 5 or 10 feet from the bridge did no effective military damage.

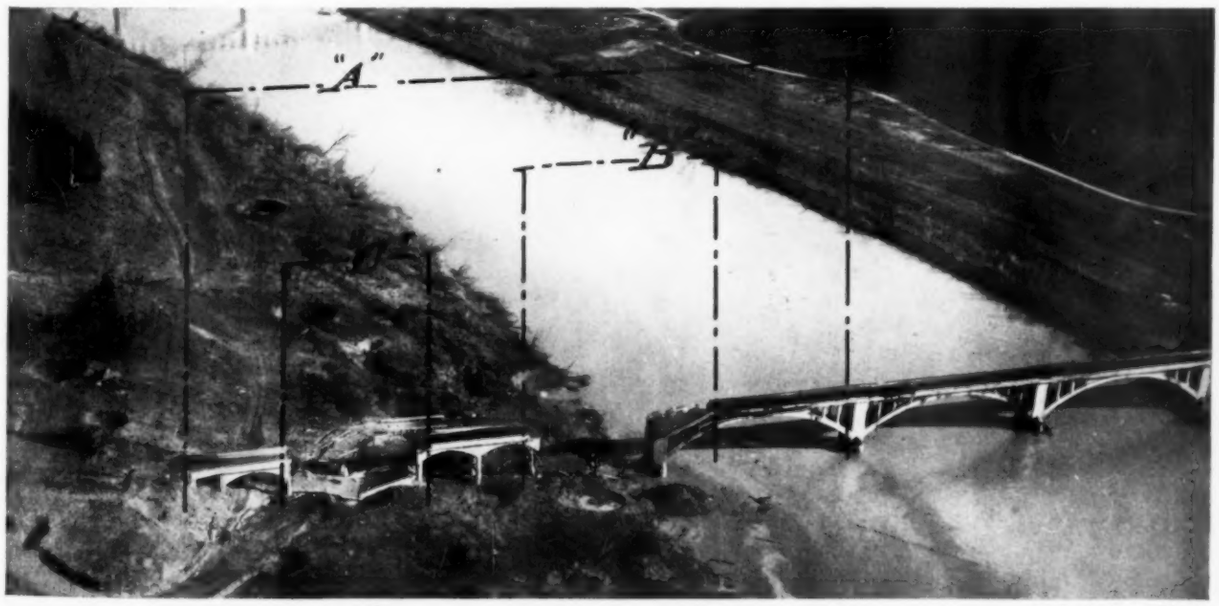


A bomber returning to Pope Field after its bombing mission over the Pee Dee River Bridge.

IT was then decided to use the 1,100-pound bomb, containing 550 pounds of TNT. There were only 18 bombs of this type available for this part of the test. The attack of the bridge with these missiles resulted in nearly 25 per cent. direct hits, and quick reduction to a mass of battered concrete and twisted steel of that part of the bridge turned over to the Army Air Corps and the Ordnance Department for experimental purposes. The first bomb which struck the bridge destroyed two approach spans of a length of 80 feet. The second bomb demolished two more of these approaches, and the last two hits, striking close to the huge pier which supported one of the three large spans over the river, put this portion of the target out of commission.

The first demolition bombs dropped were fuzed with one-tenth second detonators; later, instantaneous detonators were used for the purpose of determining which type permitted the bomb to accomplish the greatest amount of destruction. It was soon discovered that the best type of detonator for a target such as a reinforced concrete bridge was one containing a delay element.

Had the mission been one of merely destroying the bridge it probably could have been accomplished without great difficulty by the method of loading each plane of the group with 1,100-pound bombs and releasing these bombs in salvo from a nine-ship formation. However, since the purpose of the tests was not merely the destruction of the target, but obtaining valuable military data, it was necessary that the test cover several days and that certain phases be carried out under conditions not designed to cause the immediate destruction of the bridge. These phases gave to the War Department much valuable information and were most important from a technical point of view.

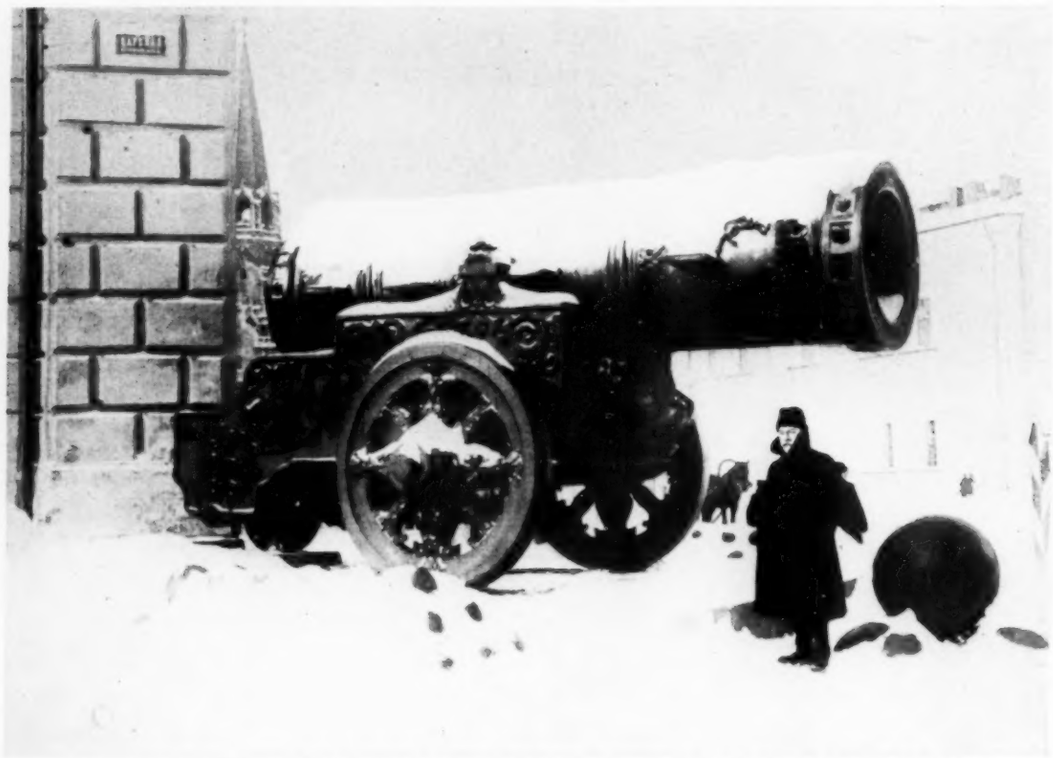


U. S. Air Corps Photo

The Pee Dee River Bridge after the Bombing Tests.

The portions indicated show: "A," section allocated to Army Air Corps for bombing; "B," damage done with three 1100-lb. bombs; "C," damage done with one 1100-lb. bomb.

Russian Ordnance--Past and Present



The famous Czar gun of the great Russian citadel, the Kremlin. This gun was cast in 1856, weighs 40 tons, and is 20 feet long. The diameter of the bore is one yard.

A Russian light field gun mounted on skis shown during recent maneuvers of the Red Army.

Italy's Gun Power Passes In Review

A battery of Italian guns on mobile mounts displayed during recent military maneuvers in Rome incident to the celebration of the fifth anniversary of the foundation of the National Militia.

Machine guns and gunners of the Italian Army demonstrate their efficiency during the recent Army review in Rome.

Antifriction Bearings in Ordnance Work

Rapid and Easy Manipulation of Heavy Ordnance Made Possible by the Use of Ball and Roller Bearings

By F. Brauer*

EARLY in the history of modern ordnance, the Ordnance Department of the Army recognized the necessity for the introduction of antifriction bearings. In fact, in several of the mechanisms in gun carriages it would have been utterly impossible to obtain the results required in specifications for ordnance without antifriction bearings.

When rolling replaces sliding at the bearing surfaces, there is a decrease in the coefficient of friction to a fraction of that of plain bearings. This reduces the power consumption and permits the introduction, if motor-driven, of smaller motors, while for hand-power operations it decreases to a considerable extent the effort exerted by the gun crew.

Lubricating difficulties with plain bearings, which require a comparatively large amount of oil to maintain the oil film, are greatly reduced by the introduction of antifriction bearings, due to less exacting requirements. With antifriction bearings, lubrication is not so important and the bearings, if the lubricant supply should fail temporarily, will still continue to operate.

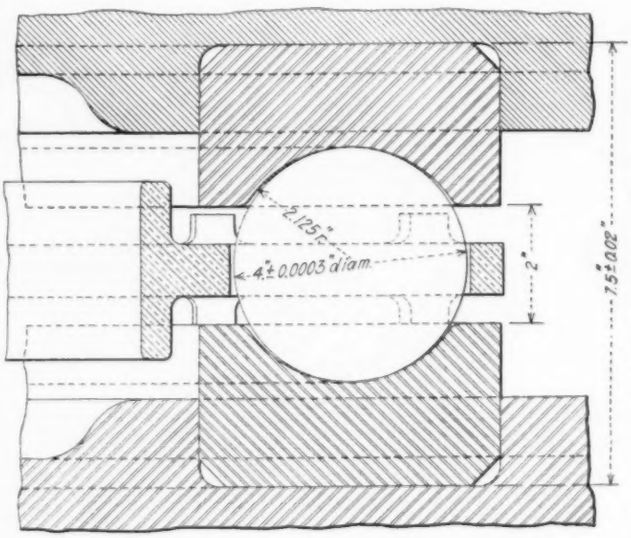


Fig. 1. Section of Lower Pintle Thrust Bearing, 14-Inch Railway Mount. Diameter at Center of Balls, 51.125 Inches.

While in most cases the rotating mechanisms on seacoast armament, including the antiaircraft projects, are of slow speed in comparison with metal-working and wood-working machinery it is essential that quick response to efforts, whether by motors or by hand, be obtained, and as ball or roller bearings have practically the same friction at starting as when running, the introduction of antifriction bearings becomes imperative.

Seacoast armament is not in continuous operation, and in most cases is "out of service" for a considerable length of time; and as its antifriction bearings require comparatively little lubricant, are quite often packed with grease instead of oil, and are provided with effective housing seals, it is possible to place it in service in a comparatively short time, while with plain bearings careful lubrication would be necessary before starting to prevent seizing of journals and other bearings.

When standing for a considerable length of time, the oil film in plain bearings will disappear, and the bearings may freeze, which may necessitate dismantling at least partially for cleaning and oiling. Plain bearings require constant attention and inspection. Even with elaborate lubrication systems there is danger of seizing. In antifriction bearings, however, the loads are carried on metal-to-metal contacts, and therefore are largely independent of conditions which seriously affect plain bearings. As long as the metal surfaces in ball, roller, or thrust bearings are not impaired, these bearings will still continue to operate and give dependable and steady performance.

With the right material, correctly heat-treated, and provided the stresses brought upon antifriction bearings are sufficiently low, there should be no tendency to wear, if dirt is excluded from them and abrasion prevented. In many parts of the gun carriage it is essential that the nominal clearance between the revolving parts be small in comparison with the clearance usually allowed in plain bearings. The internal looseness can be reduced to the very minimum in ball- and roller-bearing designs; in fact, recently it has become necessary in some of the roller bearings on antiaircraft mounts to omit internal looseness and have absolute metal-to-metal contact. Such a case is described more fully in this paper.

ONE of the earliest applications of roller bearings to ordnance was in the traversing wheels of the 8-inch disappearing carriage, Model 1894, for limited fire. The traversing wheels were conical, working on a roller path, and as it was necessary to reduce the journal friction, cold-rolled-steel rollers, held in distance rings, were used.

One of the essential motions in the control of gun fire not only requires the rotation of the gun, but practically the whole mount with the exception of the lower part, or base ring, which is securely bolted to concrete foundation. To obtain this motion involving weights from a few thousand pounds for the smaller caliber guns, to 1,000,000 lbs. for the largest caliber guns, either thrust ball bearings or conical roller bearings are used. Not only must these bearings sustain the dead weight of the rotating parts, but also the force due to the overturning movement when firing at 0 degrees elevation, while much greater stress is placed on these bearings when firing at high elevations.

The heavy roller thrust bearings of the 16-inch barbette carriages, Models 1919 and 1919M1, carry a load during firing amounting to 2,380,000 lbs., which is the weight of the rotating parts plus the component of the firing load at

*Chief Draftsman, Watertown Arsenal.

65 degrees elevation. It is obvious, that without roller thrust bearings and under conditions illustrated above, where the mean diameter of the roller races is about 28 feet, there would be a great amount of sliding friction, and hand operation, which must be provided for in event of failure of electric power.

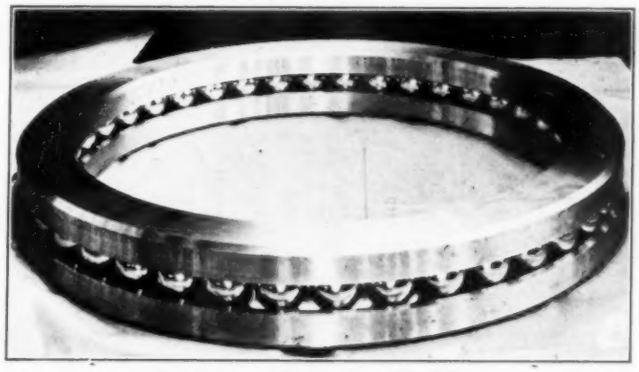


Fig. 2. Lower Pintle Thrust Bearing, 14-Inch Railway Mount, as Originally Made Without Distance Spacer.

IN the 14-inch railway mount, Model 1920, the traveling weight of which is 730,000 lbs., the ball thrust bearing consists of an upper race, a lower race, and thirty-four balls 4 inches in diameter. Both races are the same, the diameter at the center of the groove being 51.125 inches. A section through the bearing is shown in Fig. 1.

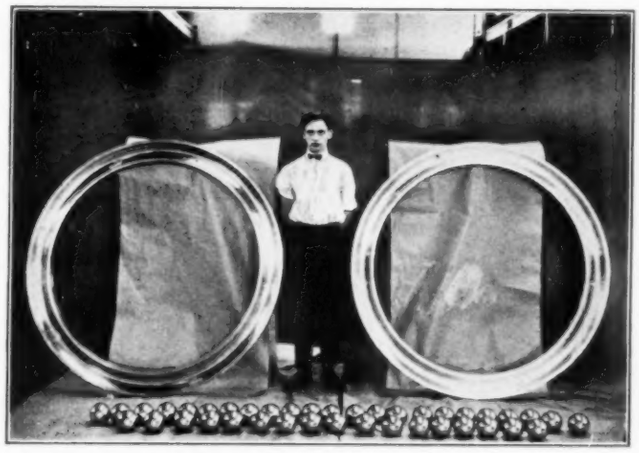


Fig. 3. Upper and Lower Races and Forty 4-Inch Balls Used in Lower Pintle Thrust Bearing, 14-Inch Railway Mount.

The races as well as the balls are made of chrome bearing steel, hardened and ground, and have a Shore scleroscope hardness number of 90 and better. The races are capable of carrying a sustained load of 100,000 lbs. on one ball applied at any point in the circumference of the groove, and each ball will stand a load of 100,000 lbs. when placed between the finished races without showing any permanent deformation or surface cracks.

The balls were tested by the manufacturer under a Riehlé testing machine using the three-ball method, wherein three balls are superimposed, the center ball being the one actually under test. The three-ball method has proved itself to be the most reliable testing method, and is replacing the old way of testing one ball between two hardened steel plates. The three-ball method is more severe, due to the fact that the ball under test is supported only by an actual point of contact instead of two flat surfaces, and the results are therefore more accurate, consistent, and reliable.

The crushing strength of steel balls under the three-ball method is determined by the manufacturer by the relation $1000 \times D^2$ where D represents the diameter of the ball in eighths of an inch. This means that a 4-inch ball would crush at a load of about 1,024,000 lbs., and as the design requires only a strength of 100,000 lbs., an ample factor of safety is obtained.

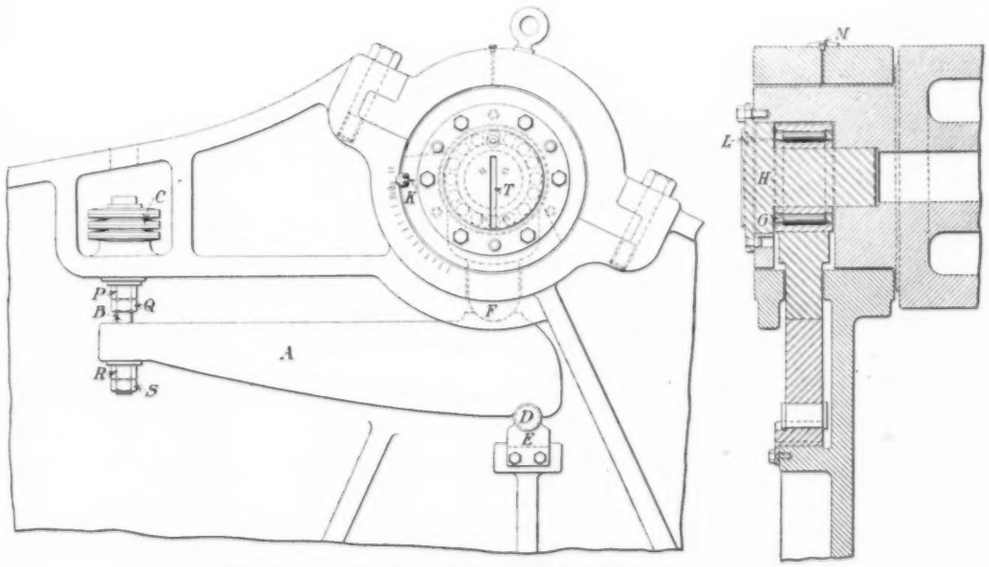


Fig. 4. Antifriction Device, 16-Inch Barbette Carriage.

A Lever
B Spring Rod
C Belleville Spring
D Crutch Spool
E Step
F Crutch
G Roller Bearing
H Bearing Pin
K Elevation Pointer
L Nipple
M Oil Plug
P Spring Rod Collar Nut
Q Spring Rod Lock Nut
R Spring Rod Collar Nut
S Spring Rod Lock Nut
T Slot

From the above analysis of this large ball thrust bearing, it would thus be possible to subject it to a perfectly safe load of 3,400,000 lbs., providing the stresses were equally divided on all the balls, and it would deform under a load of 34,816,000 lbs. uniformly distributed.

Under fire, the static load on this bearing plus the component of the firing load with gun at 50 degrees elevation is 1,246,000 lbs., and as a great many rounds have been fired at all elevations, it has been demonstrated that the roller bearing is a complete success.

In Figs. 2 and 3 are shown the forty balls which were originally provided without distance ring or spacer. Subsequently it was found necessary to dispense with six of these balls and introduce the spacer indicated in Fig. 1.

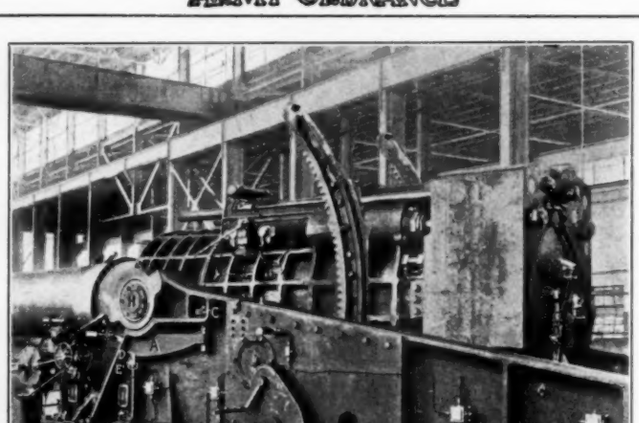


Fig. 5. Left Side, 16-Inch Barbette Carriage, Showing Antifriction Device.

A Lever
C Belleville Spring
D Crutch Spool
E Step
H Bearing Pin

Fig. 6. Fixture for Testing Antifriction Trunnion Bearings.

IN 1896 the Ordnance Department completed the design of a 12-inch disappearing carriage, Model 1896, in which elevation, traversing, and retraction were accomplished by man power. Electrification of seacoast armament not having been introduced until 1901, it therefore became necessary to use antifriction bearings in these mechanisms.

The roller bearings used were designed for manufacture at a Government arsenal. The roller cages or bushings were made of bronze in one piece, cored for the reception of the rollers which were made of cold-drawn steel, rough-filed, free from bunches, sprues, etc. Any inequalities or distortion of the cages had to be straightened so as to hold the rollers parallel to the axes of the shafts.

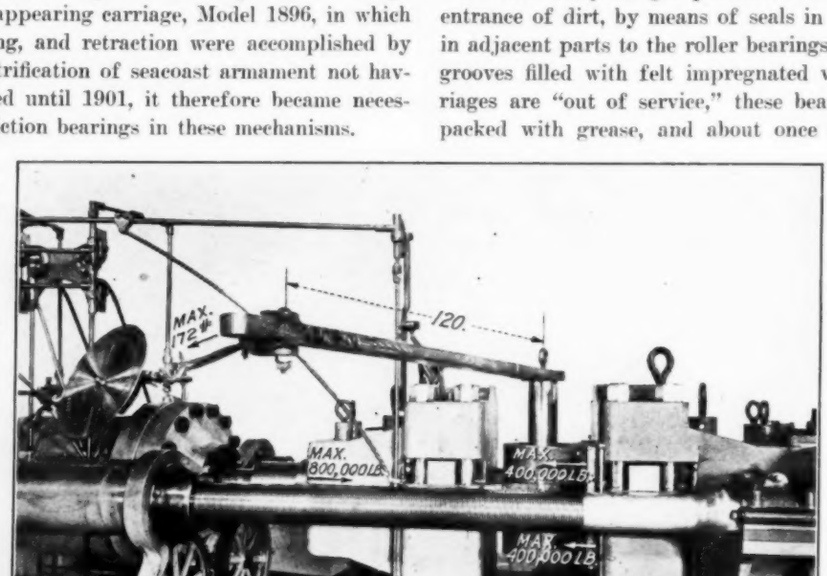


Fig. 7. Fixture for Testing Antifriction Trunnion Bearings Assembled in Testing Machine.

In these early designs precautions were taken to prevent entrance of dirt, by means of seals in the form of recesses in adjacent parts to the roller bearings or by collars having grooves filled with felt impregnated with oil. When carriages are "out of service," these bearings are completely packed with grease, and about once a year or whenever maneuvering or target practice require, are cleaned out. When again put "in ordinary," the bearings are again packed with grease and sealed up.

While these bearings were a great improvement over plain bearings, and worked satisfactorily under the loads brought upon them, the manufacture by the Government was soon thereafter discontinued, as bearings could be obtained commercially from one of the pioneers in the field of roller bearings, the designs meeting all requirements and giving better results.

The ball thrust bearings used in the mechanisms were likewise manufactured at a Government arsenal, but this practice was soon discontinued in favor of commercial bearings which could be obtained of better qualities and at less cost. It is a fact, however, that bearings made at a Government arsenal in 1896, and subsequent bearings made a year or two after by a bearing concern, are still giving good service on carriages at the fortifications.

THE most severe stresses that roller bearings have been subjected to in ordnance design are in the trunnions of cradles in which the gun slides during the recoil. Antifriction bearings in trunnions have been applied for

Table 1. Data Sheet, Notation, and Formulas, Test of Trunnion Roller Bearing for 16-inch Barbette Carriage

W = Load applied in pounds
Fa = Average starting force in pounds
Ta = Average starting torque in inch-pounds
Rc = Distance of center of rollers to center of bearing in inches
r = Radius of rollers
u = Coefficient of friction
$Ta = 120\,Fa \quad Ta/Rc = Wu/r \quad u = rTa/RcW$

Load applied	Starting force at end of 120-inch lever. Through angle of 72 degrees.						Fa	Ta	u
W	1	2	3	4	5	6			
50,000	3	4	4	3.5	4	3	3.5	420	0.00105
100,000	4.5	4	6	0.5	1	5	3.5	420	0.00052
150,000	3	5	5	0.5	4	3	4.25	510	0.000425
200,000	5.5	9	9.5	0.5	7.5	10	7.00	840	0.00052
250,000	25.3	20.83	9.66	9.60	10	6.6	13.70	1644	0.00082
300,000	22	11	24	18.66	5.33	14	15.72	1884	0.000783
350,000	19.3	9.67	15.67	14	11.4	12.67	13.8	1656	0.00059
400,000	27.5	22.17	15.17	20.67	17	13.67	19.36	2316	0.00072
450,000	24.33	19.50	18.50	22.30	17.33	23.0	20.83	2496	0.00069
500,000	34.67	23	26.67	40.33	32	27.3	30.7	3684	0.00092
550,000	35	35.3	42	40.3	32	37	36.9	4428	0.00101
600,000	37	42.3	53.67	37	47	48.7	44.2	5316	0.0011
650,000	46.3	48.67	77	60.3	52	50.3	55.7	6684	0.00129
700,000	78.67	82	83.67	83.67	85.3	80.3	82.27	9872	0.00176
750,000	107	95	105.5	104.5	125	87	103.9	12480	0.00208
800,000	122	142	172	151	157	122	144.3	17316	0.00270

heavy duty in gun carriages from 3 inches up to 16 inches, in order that the elevation and depression may readily be accomplished in the shortest possible time.

By the introduction of levers and fulerums and Belleville springs, in conjunction with the antifriction or roller bearings, it is possible to manipulate with perfect ease and in a short interval of time the tipping parts consisting of the gun, the cradle, the cylinders, and other details which rotate around the trunnions of the cradle. The dead weight of these parts amounts to 500,000 lbs., or 250,000 lbs. on each trunnion in the case of the 16-inch gun barbette carriage, Model 1919. This arrangement is shown in Figs. 4 and 5. Levers *A*, one on each side of the carriage, are supported at one end by spring rods *B* which pass through and are supported by Belleville springs *C*. The other ends of the levers are supported on crutch spools *D*, which in turn are supported by steps *E* which are bolted to a web on the side frames. The crutches *F*, their upper faces being curved to fit the outer sleeves on the roller bearings, are placed on their seats on the levers. Trunnions on the cradle which are shown in cross-section in Fig. 4 are bored to receive bearing pins *H*, and the roller bearings *G*, and the lower part of the trunnions are cut out to provide space for the upper end of the crutches *F*. Bearing pins *H* with the roller bearings *G* are put in the trunnions, and the bearing pins are bolted in place. After the tipping parts have been placed in the side frames, the trunnions are raised from their seats in these frames and supported by crutches *F* in such a position that there is no contact between the trunnions and bearings in the side frames. This adjustment is made by means of nuts *P*, *Q*, *R*, *S*, and spring rods *B*. The weight of all the tipping parts is now carried on the roller bearings, and this condition exists at all times except when the gun is fired, at which time the force due to the powder gases at elevations above 0 degree compresses the Belleville springs *C*, and the trunnions seat themselves in the main bearings in the side frames. After the effects of the force due to the powder gases have been dissipated, being absorbed by the recoil mechanism, the trunnions return to their original position. Lubrication of these bearings is provided by use of Alemite lubricators. Thickness gages, one for each trunnion, are provided with each carriage so as to gage the clearance between the trunnions and the trunnion beds. The thickness of these gages equals half the diametrical clearance, the exact thickness being determined during the shop inspection, on account of possible variation in the machining of the bored and turned parts. In order that the trunnions may float with perfect freedom in a horizontal plane, it is necessary that the exact opening for gaging this flotation be determined for either side of the carriage, the anticipated diametrical clearance being 0.04 of an inch, which will make the gages 0.020-inch. These may vary by a few thousandths depending upon the exactness of the machining to basic dimensions.

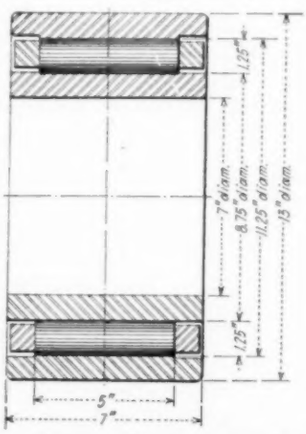
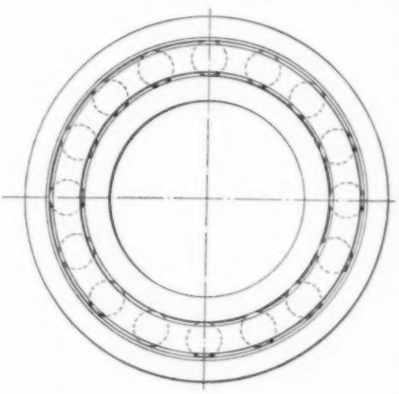


Fig. 8. Roller Bearing for Trunnion of 16-Inch Barbette Carriage.

A TEST was made in 1919 to determine whether the bearings designed for the trunnions of this carriage would stand the strain that would be brought upon them, and the results obtained surpassed all expectations, in that it was possible to subject these bearings to a load of 800,000 lbs. without deformation or change in dimensions.

In the test three pedestals shown in Fig. 6 were used. One of the bearings was placed in one of the heads of the testing machine, the two other bearings joined by a plate in the other head of the machine, and an axle inserted as shown in Fig. 7. At the end of the axle a 120-inch lever was attached, at the end of which a spring balance was applied, so that for various increments of loads, by rotating the shaft,



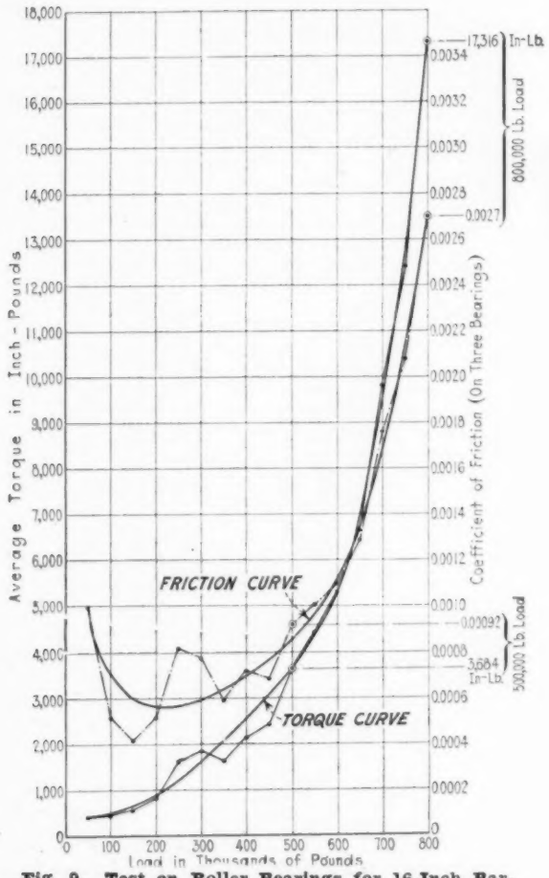


Fig. 9. Test on Roller Bearings for 16-Inch Barbette Carriage.

the force could be readily ascertained. By using this apparatus a very accurate test of these bearings under various loads was made.

The roller bearings, that is, the inner and outer sleeves, as well as the rolls, were made of chrome bearing steel, the rollers having a Shore scleroscope hardness of 90 to 100, and the inner and outer sleeves a scleroscope hardness of between 85 and 95. The roller bearings are shown in Fig. 8. From Table 1, it will be noted that the loads were applied by increments of 50,000 lbs. The starting-force readings were recorded by means of a dial spring balance fastened to the lever arm of 120 inches in length. This lever fitted over the top of an axle 7 inches in diameter which served as a spindle for the three sets of rollers held in the fixtures in the testing machine.

In Fig. 9, the coefficient of friction and the torque as functions of the load have been plotted from the data of Table 1. It will be noted that at the load of 50,000 lbs. the coefficient of friction is 0.00105, and that for subsequent increments of load of 50,000 lbs. up to 550,000 lbs. the coefficient of friction is

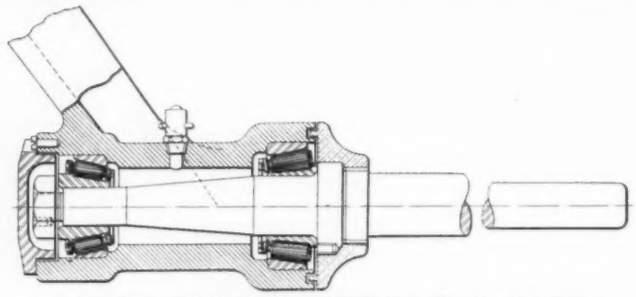


Fig. 10. Roller Bearings Applied to Handle for Hand-Operated Rotating Mechanism.

less. From that point on it gradually increases up to 800,000 lbs. applied load.

As several tests made on different bearings of the same type gave practically the same results, these variations can be explained by the fact that at the application of a load of 50,000 lbs. the bearing was moved considerably back and forth by effort on the end of the lever, thus probably ironing out any small irregularities that could not be detected by measurements, so that with subsequent loads the coefficient of friction was thereby reduced slightly. It was also noticed in several of these bearings that at the load of 250,000 lbs. the coefficient of friction was slightly higher than at the 300,000 lbs., and this can only be attributed to slight irregularities which have been ironed out, or a change of position of rollers. At any rate, it gives a fair illustration of conditions which may be met in bearings of this size, and under heavy loads.

Although not shown in the illustration, a counterpoise was hung on the lever placed at 180 degrees from the lever arm so as to balance the "over-hang" of lever and spring balance. As each increment of 50,000-lb. load was applied, the starting force was recorded through an angle of 72 degrees, this being the angle through which this bearing will work when inserted into the trunnions of the 16-inch barbette carriage, each movement representing from minus 7-degree depression to plus 65-degree elevation. Three readings of the starting force were taken at each angle of 12 degrees, thus making a total of 18 readings for each increment of load applied.

For each increment of 50,000 lbs. above 150,000-lb. load, the bearing was taken out, examined, and rollers and sleeves or casings carefully measured to detect any deformation which might have occurred. Special care was taken in measuring the rollers which came directly in line where the force was applied, and lying within the 72-degree service angle.

The observations and measurements during and after the

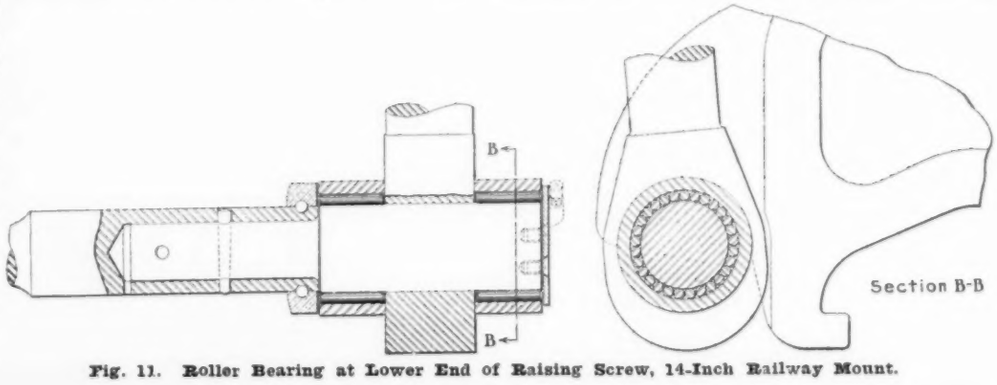


Fig. 11. Roller Bearing at Lower End of Raising Screw, 14-Inch Railway Mount.

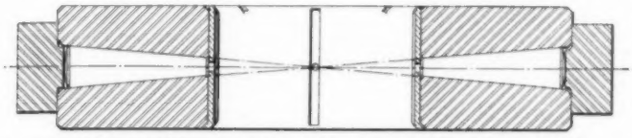


Fig. 12. Cross-Section of Roller Thrust Bearing to Withstand Load of 168,000 Lbs. at 3 R. P. M.

test demonstrated that the rollers and casings were safe for all loads applied in this test. Since the maximum of 800,000 lbs. applied to the middle roller bearing, or 400,000 lbs., which would be the reacting force on the two other roller bearings, produced no deformation, and as the actual static load on these roller bearings when the tipping parts of the 16-inch barbette carriage are applied thereto would be 500,000 lbs., or 250,000 lbs. at each trunnion, it was the opinion that these bearings could be used in service with security. Many rounds have been fired from guns mounted on the 16-inch carriages, and no failures of bearings have been recorded.

The 120-inch lever used in the test of these roller bearings was selected because the pitch radius of the elevating rack on the gun carriage for which these bearings are intended has a radius of 120 inches, and it will be noted from Table 1 that if the conditions obtained in the testing machine should prevail when the tipping parts were assembled on the carriage, it would only take an average of 30.7 lbs. at that distance from the center of rotation to start rotation of the 500,000-lb. weight, provided this weight were perfectly balanced and the coefficient of friction were 0.00092.

As the middle bearing in this test was subjected to the full load, each of the outer bearings would carry half of this load, and as the coefficient of friction shown in Table 1 and Fig. 9, represents the coefficient of friction on the three bearings it may therefore, be assumed that the middle roller bearings would have a coefficient of friction of one-half of that in the table, and that each of the outer roller bearings would have one-fourth of the coefficient of friction as tabulated, which would bring it down to a very small figure.

Eight highly satisfactory tests were recently made of similar bearings, the results being a little better than those obtained during the test in 1919. In these eight tests the average effort on the 120-inch lever was 26.06 lbs. for a load on the center bearing of 500,000 lbs., which, according to the formulas used herein, would give a coefficient of friction for the three bearings of 0.0008, or for the middle bearing, 0.0004, and for each of the two outer bearings, 0.0002.

While the data obtained during the test of these bearings indicated conditions beyond anticipation, it was not expected that the same conditions would materialize when these roller bearings were inserted into the trunnions of a cradle, due to the fact that in the test the supports for the roller bearings were close to each other, while in the case of a cradle, the roller bearings will be assembled to the trunnions, which are 8 feet apart. The insertion of the gun causes a deflection which cannot be avoided, and which throws any perfectly aligned trunnion and trunnion bearings slightly out of their true axis. The fact of the matter is that when these roller bearings were inserted into the trunnions of the cradle of the 16-inch barbette carriage, with the gun mounted therein, the results obtained justified the adoption of this form of bearings to obtain flotation of the tipping parts of heavy ordnance material.

The coefficient of friction obtained with cradle and gun mounted was 0.0062, derived as follows:

$$u = \frac{rT_a}{R_c W} = \frac{0.625 \times 40 \times 620}{5 \times 500{,}000} = 0.0062$$

in which

u = coefficient of friction
r = radius of rolls
620 = the distance in inches from center of rotation to muzzle of gun
40 = the force in pounds at the muzzle required for rotation
5 = the distance in from the center of rotation to center of rolls, and
500,000 = the weight in pounds of the tipping parts.

This difference in the coefficient of friction, while considerable, is due to springing or deflection in the cradle and possibly to slight inaccuracy in obtaining perfect alignment in manufacture. Even at that, a coefficient of rolling friction of 0.0062 under such conditions is very acceptable.

To determine the power consumption and the advantage gained by the introduction of the roller bearings in the trunnions of the 16-inch carriage cradles, careful tests were made under power, as well as by hand. If plain bearings had been provided in the trunnions, it would have been impossible to obtain the results achieved, as the elevation of the gun to 65 degrees and a return to the 4-degree loading angle form part of the cycle of the complete operation to be able to fire a 2340-lb. projectile every minute.

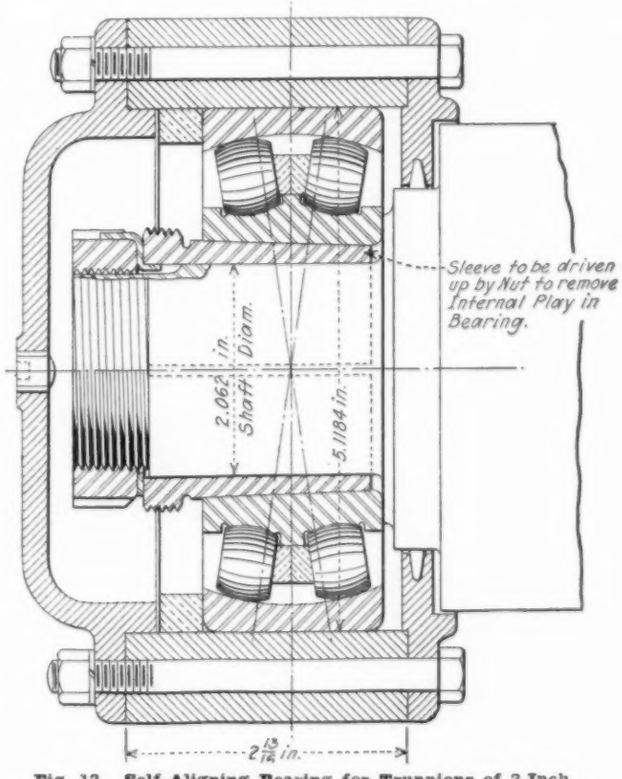


Fig. 13. Self-Aligning Bearing for Trunnions of 3-Inch Antiaircraft Gun.

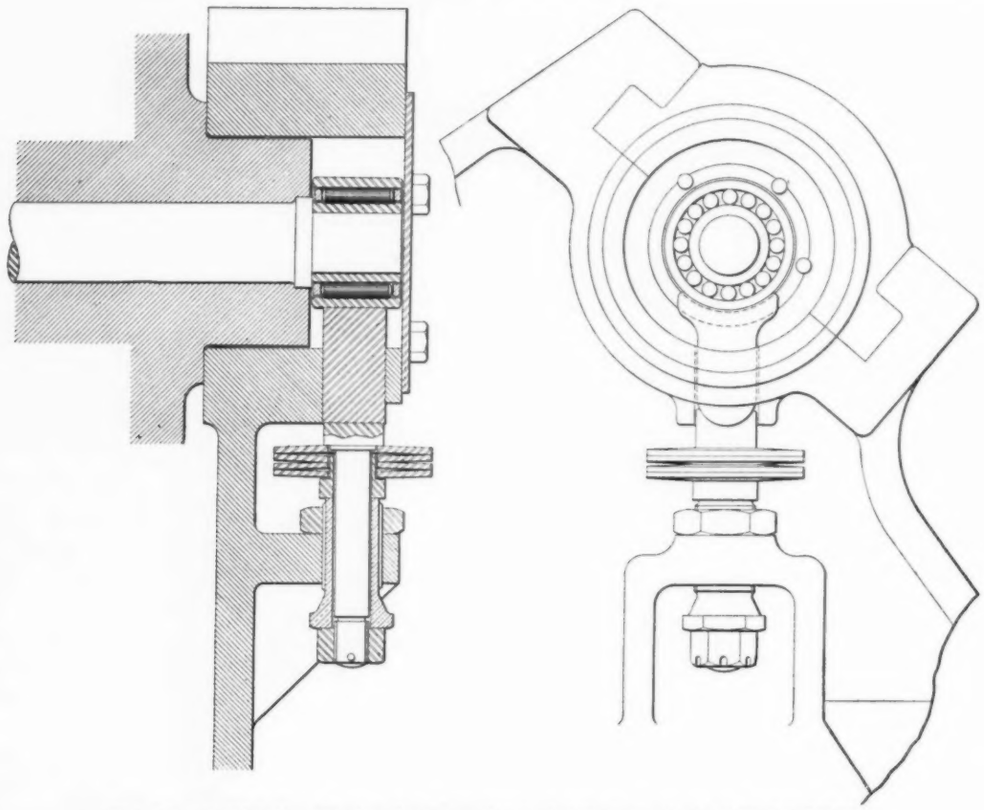


Fig. 14. Antifriction Device for Trunnions of 3-Inch Project of Model 1917M1.

As an illustration: With the gun at 0-degree elevation and the tipping parts in perfect equilibrium (the center of gravity of these parts is in the center of the trunnions), and with the *antifriction device engaged,* that is, the rotating parts floating on the roller bearings, the effort to overcome the starting friction with the slow-motion mechanism was 19 lbs., and with the fast-motion mechanism in gear, 49 lbs. On the other hand, with the *antifriction device disengaged,* in other words with the main trunnions of the cradle resting on the solid trunnion bearings, thus transferring the load to plain bearings, the effort for the slow motion was 280 lbs., and for the fast gearing, 641 lbs.

With the *antifriction device engaged,* using electric power, it was possible either to elevate or to depress the 500,000 lbs. through an arc of 72 degrees in 8½ seconds, whereas, operating by hand and using the slow motion, it required about 50 seconds, and for the fast motion, about 35 seconds. In contrast thereto, attempts to rotate by hand with the *antifriction device disengaged* for the purpose of obtaining the time failed, as the efforts stated above were so great that it was merely possible to overcome the starting friction, and any movements of the tipping parts were difficult to discern. In other words, it was practically impossible to move the piece with the antifriction device disengaged except by the exertion of an excessive amount of electric power which taxed the motor to its extreme capacity, and at an extremely slow rate.

It has been intimated that antifriction bearings in gun trunnions are subjected to excessive shocks, but this is not the case when bearings are floating. For instance, for the 16-inch gun and carriage under discussion, the static load on each bearing is 250,000 lbs. At the instant of firing there is a powder pressure at the breech of the gun of 8,600,000 lbs., and if there were no recoil, half of this load would come on each trunnion. The gun recoils 40 inches, and the retarding motion is so designed that in this length of recoil there is a constant resistance of 1,600,000 lbs., so that 800,000 lbs. is the actual force due to the powder pressure on each trunnion. This force of 1,600,000 lbs. does not come on the roller bearings which float away with the trunnions for a distance of 0.02 inches, so that the brute metal of the trunnions is against the solid bearings in the side frames. At no time during firing at any elevation is the retarding force brought upon the roller bearings in the trunnions, due to the elastic medium of the spring actuating levers when fired at any elevation above 0 degree. For horizontal firing the cradle trunnions merely rock on the crutches until the small clearance is taken up and the force of recoil is then on the solid bearings.

FOR many years, in various ordnance mechanisms, loose bronze sleeves, provided with means for oiling, were assembled over steel handles. The operator would then grip this sleeve which would rotate around the handle, permitting the exertion of whatever effort would be required without the slipping of the grip.

When a gun carriage has been out of service for a considerable length of time, the bronze sleeve is likely to freeze to the handle and prevent rotation so that the operator's hands will slip and probably blister. For this reason roller bearings were introduced at the end of the crank handle in the housing of the crank proper, thus dispensing with the sleeve, and operators can now grip the metal handle firmly. This arrangement is shown in Fig. 10.

IN the 14-inch railway mount, Model 1920, it is necessary to raise and lower the gun with the other tipping parts, as well as a portion of the top carriage, from the traveling position to the firing position and back again. In the mechanism there are two high-grade-steel screws and manganese-bronze nuts, each screw, in performing this work of raising and lowering, being subjected to a load of 140,000 lbs.

Not only is the end thrust of each screw taken by conical rollers, but as the housing in which the screw and nut rest is trunnioned to permit slight rotation during the raising and lowering of the gun and appertaining parts to and from the firing position, it was necessary to introduce roller bearings at each trunnion, each of these bearings being subjected to a 70,000-lb. load.

In addition to the trunnion roller bearings, ball bearings are interposed in the vertical plane between the housing and the nut to eliminate excessive friction at the two points of application on which forces are exerted during the slight rotation of the housing.

During the raising and lowering of the gun by means of the two screws, the lower end of each screw being hinged at the bottom, a slight movement is created around the center of the hinge, for which originally plain bearings had been provided. It finally became necessary, in order to prevent the screws from bending, to introduce the roller bearings in Fig. 11. As the space for the introduction of antifriction bearings was very limited, it was necessary to crowd in as many rollers as possible without the use of a cage, and as the movement there is very slight, amounting to only a few degrees during the operation of lowering and raising, tests demonstrated that the trouble originally experienced with plain bearings at the points in question was entirely eliminated by the introduction of these special roller bearings. Each of the roller bearings at the lower end is subjected to a load of 70,000 lbs.

IT is also necessary to raise and lower the whole 14-inch mount so as to obtain clearance between the rails and the lower base plate when in transit, and to lower it for firing on a permanent emplacement, or for the removal of the trucks when fired from a field emplacement. This is accomplished by means of four screws made of high-grade steel in bronze nuts, and the thrust is taken up as in the case of the top-carriage raising screws by four conical roller thrust bearings, the total load on which is 672,000 lbs., or 168,000 lbs. on each bearing.

These bearings were tested for the designed loads in pairs on a specially devised fixture. The coefficient of friction for the two bearings was 0.004, or 0.002 for one. A cross-section of these bearings is shown in Fig. 12. These bearings had to be made with almost mathematical precision, and accurate gages were provided by the manufacturers, and the Government also provided a special test gage for inspection.

SPECIFICATIONS for roller thrust bearings for mount-lifting mechanism and top-carriage raising gear for 14-inch railway mount, Model 1920, are in part as follows:

The high-carbon steel designated on the drawings as steel W. D. 52,100, shall have the following chemical composition in percentage:

Carbon	0.91-1.10
Manganese	0.20-0.50
Phosphorus (maximum)	0.03
Sulphur (maximum)	0.03
Chromium	1.20-1.50

The scleroscope hardness as required by the drawings and between the limits specified must be obtained by the proper heat treatment, namely, for rings and races 80 to 90, and for rollers 75 to 80.

The retaining ring which is used in the roller thrust bearing for the mount-lifting mechanism, only, shall be made of bronze No. 5, in accordance with Ordnance Department, U. S. A., Metal Specifications No. 57-70A, dated July 23, 1924.

In order to insure that the bearings furnished are suitable before actual trial in the mounts, the following conditions shall be complied with:

(*a*) Each roller to be tested individually for correctness of spherical surface at large end—first by use of the inspection gages, and then by placing the spherical end against the inner surface of the thrust ring, and viewing against strong light. No light should pass.

(*b*) Test rollers for angle of taper and location of spherical end from apex of cone.

(*c*) Cross-section of rollers must be truly circular $\pm$ 0.0001 inch.

(*d*) Test for correctness of angle on races.

(*e*) Soundness of parts: drop test for rollers and sounding races and thrust rings.

(*f*) With all the rollers pushed together so as to touch, the clearance gap should have its sides radial, and of a magnitude at the large end equal to 0.025 inch as prescribed on the drawings.

(*g*) With rollers in place on one race, the other race should be thinly coated with prussian blue, and a test made for uniform bearing on all rollers.

(*h*) The overall thickness of the assembled bearing must be made to the prescribed dimension as shown at assembly view, namely, $1.875 \begin{matrix} +0.001 \\ -0.000 \end{matrix}$ inch.

(*i*) So that the Government inspector may be able to inspect, accurately, the races and rollers for the mount-lifting mechanism, the retaining rings should not be crimped by the manufacturer until after this inspection has been made, and not until after the test prescribed in the following sub-paragraph (*j*) has also been made at the Watertown Arsenal, and if this test is satisfactory and the bearings otherwise accepted, then the retaining rings are to be crimped in place.

(*j*) All of the completed bearings are to be tested in pairs at the Watertown Arsenal before acceptance.

(*k*) With a total pressure of 140,000 and 168,000 lbs., the coefficient of friction of one bearing should not exceed 0.004 for top-carriage raising bearings and for mount-lifting bearings, respectively.

IN recent designs of gun carriages for comparatively small-caliber guns, antifriction bearings have been introduced in the trunnions and pivots, the loads due to the firing being transmitted directly on the bearings. Preliminary tests have demonstrated that the bearings thus far tried out are satisfactory.

In a recent design of a 3-inch antiaircraft project, as well as in a design made about a year ago of the 155-mm. howitzer carriage, both of which are practically completed and will undergo proof-firing very shortly, advantage was taken of antifriction bearings at the most critical points where the stresses are most severe, and on which depend the speed by which the gun can be elevated or traversed. The difference however in the two designs, so far as the bearing question is concerned, is with reference to the kind of bearings introduced. In the 3-inch antiaircraft project, self-aligning bearings have been specified, whereas in the 155-mm. howitzer project, straight roller bearings have been provided.

In the 3-inch project, the force required to control the recoil over its length is 18,000 lbs., which brings 9,000 lbs. on each of the self-aligning bearings at the trunnions, and there is a reacting force of 13,400 lbs. at the lower end of the pivot, which comes on one bearing.

The guaranteed capacity for 0 revolutions is 28,000 lbs., which should give an ample factor of safety.

On the 155-mm. howitzer project, however, where plain roller bearings have been introduced, the forces are much greater, and to control the recoil due to the powder gases during the length of recoil, a force of 50,000 lbs. is required. This brings 25,000 lbs. on each of the plain roller bearings. The reacting force at the lower end of the pivot is 104,000 lbs., which comes on one roller bearing, and in this design a plain roller bearing has also been introduced in the middle of the pivot, the combined load on which is the sum of the upper and lower forces, and thus amounts to 154,000 lbs.

A rather neat arrangement has been provided by the manufacturer of the self-aligning bearings used on the 3-inch antiaircraft piece to obviate any looseness or clearance whatever between the inner and outer races and the rollers. (See Fig. 13.) As this gun is controlled in elevation by instruments which are controlled from a central station or control room, the motive power of which is accurately synchronized, it is necessary to obviate all looseness between metal-to-metal working parts, in order that "follow-the-pointer" method will set the gun in elevation accurately as determined in the control room.

As manufactured, these bearings may have 0.001-inch looseness between the rollers and their surfaces, but by introducing a split bushing slightly tapered on the outside, which engages the correspondingly tapered surface of the inner diameter of the inner race, and by a screw adjustment from the trunnions, the tapered bushing is forced inward, thus expanding the inner race, and eliminating all looseness. This operation, however, must be very carefully made and only by an engineer who is familiar with this work, otherwise with too much expansion strains are set up in the parts affected, which, when the firing load is applied, may result in failures.

No such arrangement is necessary on the 155-mm. howitzer project as controlling instruments are not used with it.

A rather neat arrangement of floating roller bearings in the cradle trunnions on the 3-inch project of Model 1917M1 is shown in Fig. 14, where plain roller bearings are used. Belleville springs are introduced for a yielding medium. The static load on each bearing is about 4,000 lbs., whereas the force due to the firing is 15,000 lbs. on each trunnion. As there is only 0.008 inch clearance under the trunnion, the two pairs of Belleville springs will yield to this amount, after which the main force will come on the solid trunnions and trunnion seats. The method of adjustment is shown clearly in the illustration.—*This article is reprinted by permission from Mechanical Engineering, Vol. 49, No. 9, September,* 1927.

Louvain Memorial to American Engineer Heroes

ON JULY 4, 1928, forty-eight gold stars will shine in the four clock dials of the new Library at Louvain, Belgium, and from its belfry the forty-eight sweet-toned bells in its carillon will vibrate the music of America, Belgium and other countries in memory of the hundreds of engineers of the United States who gave their lives in the World War. Engineers in every one of our forty-eight states and the territories have made an investment in this unique memorial which will be seen and heard while doing helpful service through centuries to come.

The memorial library building, being given by Americans, and the Engineers' Memorial clock and carillon, will be dedicated with impressive ceremonies on Independence Day. All engineers from the United States who expect to be in Europe next summer are urged to plan their travels so as to be in Louvain to participate in the dedication.

For the accommodation of engineers and friends who as yet have not found it convenient to contribute to the Engineers' Memorial fund the time for receiving contributions has been extended because the Committee desires the memorial to be as representative as possible. However, early responses will be appreciated as the Committee plans to record the names of all donors in a beautiful memorial volume to be suitably placed in the Louvain Library. Remittances in any amount from one dollar to five thousand, may be sent to United Engineering Society, at 29 West 39th Street, New York.

The Memorial Committee also requests assistance in making as complete as may be its Honor Roll of the Engineers who gave their lives in any service of the United States or its Allies in the World War, overseas, on the seas, or in this country. Lists from regimental or other military or naval veteran organizations are especially desired, together with their contributions to the fund. Arrangements may be made to have names of deceased members recorded in the memorial volume in groups under the names of the organizations. Several such units have already been enrolled and have contributed. Others are invited. Arrangements will be made for additions to the memorial record of all acceptable names received within a reasonable time.

The Gage Laboratory at Watervliet Arsenal

By L. W. Dwyer*

IN the manufacture of cannon, accuracy and interchangeability go hand in hand. The very key to success in the modern manufacture of interchangeable parts is, not how accurate must we work, but how inaccurate can we work and still have the parts function.

The modern cannon is composed of from one hundred to one hundred and fifty various components. These parts must assemble and produce a serviceable weapon.

In former years it was the custom to give flat dimensions on drawings, assuming that the shop would make the parts fit. This could be done where the work was all performed in the one shop. A system of gaging was used whereby a pair of gages was made, that would fit together. These would produce two mating parts which could be assembled. Of course, if the work should fit the gage a trifle loose, or the gage should have a little shake in the work, it was a matter of judgment whether it was acceptable or should be rejected, and you can rest assured that there was many an argument between the inspector and the workman. It took longer to produce the work, and kept the scrap pile at high peak. Working to these gages with no prescribed tolerance, a great deal of time was wasted in attempting to obtain this unnecessarily accurate fit. Usually the parts, though still functioning satisfactorily, were much less accurate than the gages. It would be impossible to give a first class mechanic a drawing and measuring tools and expect him to produce pieces absolutely alike.

Checkers Inspecting Gages, Watervliet Arsenal.

It was for this reason that a tolerance—the amount of variation permitted in the size of a part—is added to working surfaces. Tolerance is not to be confused with allowance, which is an intentional difference in the dimensions of mating parts. This tolerance was shown on the working drawings and reproduced in the gages, thus allowing the workman wider limits for finishing the parts, doing away with unnecessarily high personal skill and the sense of touch, and appreciably decreasing the number of rejections.

The limit system has therefore been adopted in gun work, just as it has become the recognized standard for production in the mechanical field of today.

During the World War the vital importance of gages was of great concern to the Ordnance Department. With the limit system adopted production was rapid, and the scrap pile kept at a minimum. It also permitted the various parts to be produced in small machine shops throughout the country.

A gaging system can be simple and inexpensive, or it may be very elaborate and costly; parts can be over-gaged as well as under-gaged.

The gages used in the Ordnance Department are classified as follows:

Master Gages: The dimensions represent as exactly as possible the physical dimensions of the component. They are the gages to which all other gages and all dimensions of manufactured material are finally checked or compared, either by direct check or comparison.

Inspection Gages: Used by the Ordnance Department in accepting the product. These gages must not accept any product which the master gages will reject.

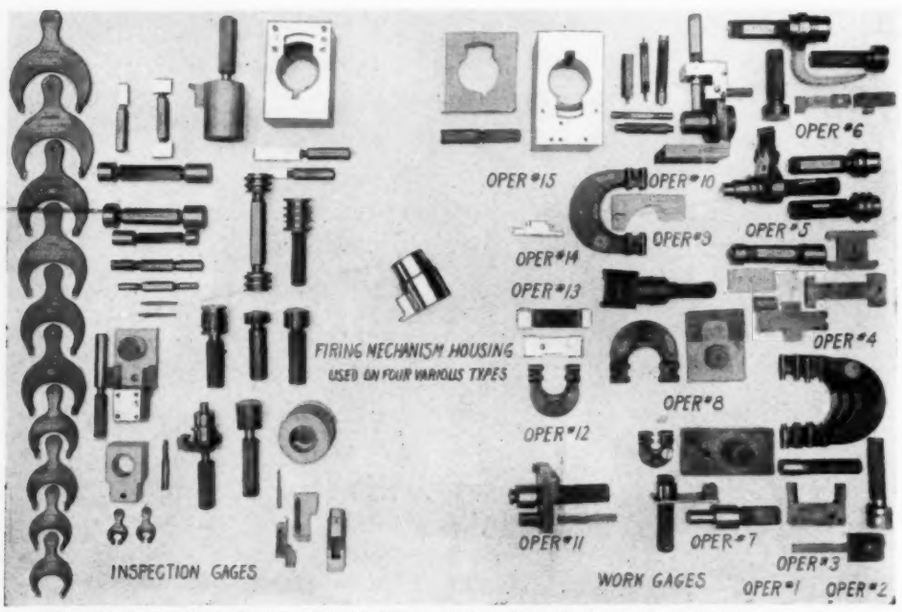
Work Gages: Gages used by the manufacturer to check the work as it is produced. These gages should not accept any product which the inspection gages will reject.

The Gage Laboratory at Watervliet came into being at the close of the World War. It is one of six located in various parts of the country, and under the control of a central Gage Section in the office of the Chief of Ordnance at Washington, D. C. In the laboratory at Watervliet Arsenal, all gages pertaining to cannon are inspected, recorded and stored.

Prior to the World War most of the cannon manufacture was done at Watervliet Arsenal, and the design, inspection and storage of gages was taken care of by that station. At the beginning of the war it was impossible for the arsenal to manufacture all the cannon needed by the Army, so contracts were let to various private plants for the manufacture of guns. These commercial plants engaged in the production of cannon, designed their own manufacturing gages, and the Ordnance Department furnished the inspection gages. The war over and contracts settled, the manufacturing gages became the property of the Ordnance Department, and were shipped to Watervliet. About 50,000 gages—good, bad, and indifferent—were received. A gage laboratory was established in one of the spare buildings and the personnel recruited from the arsenal force. A foreman and a gang of laborers set up work benches and storage racks, after which the gages were unpacked, cleaned, and sorted for each model of cannon.

*Chief, Gage Section, Watervliet Arsenal, Watervliet, N. Y.

THERE are very few gage makers in the country, and this is one of the reasons why the Ordnance Department is laying such stress on gages. A good toolmaker is not always a gage maker. Gage-making is a trade all by itself. However, Watervliet was fortunate in having at that time some of the best tool-makers in the country, and a few good gage makers. These men were transferred to the gage laboratory. The most efficient were appointed leaders, each leader having supervision over four other checkers. It was the leader's job to sort out the work for his checkers according to the ability of the latter, and they were held responsible for the accuracy and quantity of the work produced. In this way the job was put on a production basis. All gages were checked to the latest revised manufacturing drawings. Gages of poor design; gages that could not possibly be applied; broken and obsolete gages; gages that it would cost more to correct than to produce—all were scrapped, about 10,000 in number.



The 39 Inspection Gages and 45 Work Gages Required in the Manufacture of a Firing Mechanism Housing.

When a gage was inspected and found serviceable, a record slip was prepared by the inspector, checked by the leader, and sent with the gage to have an identification number assigned. This identification number was etched on the gage by an electric etchograph. The gage was then coated with grease to prevent oxidation, and as a further precaution was wrapped in oiled paper and assigned to a locker. Five gage record cards were made for each gage—two being forwarded to the central office at Washington, and three being filed under separate headings at this depot. Each individual gage has its own identification number. This is due to the fact that, although several gages may be manufactured for the same identical purpose, the actual measurements of each will usually differ slightly. Each record card gives complete information pertaining to that individual gage, namely, the type, function, the component part on which it is to be used, the operation to be checked, the last revision of the drawing of the component, the last revision of the gage drawing, the cost, prescribed dimensions, actual dimensions and variations, the locker or rack in which it is stored, the place from which the gage was received, and a full record of each time the gage was issued and received back. With this record available we are in a position today to tell immediately what is needed for production, and can promptly assemble the gages for a complete gun, or for any component, for use at this establishment, or for shipment to an outside manufacturer.

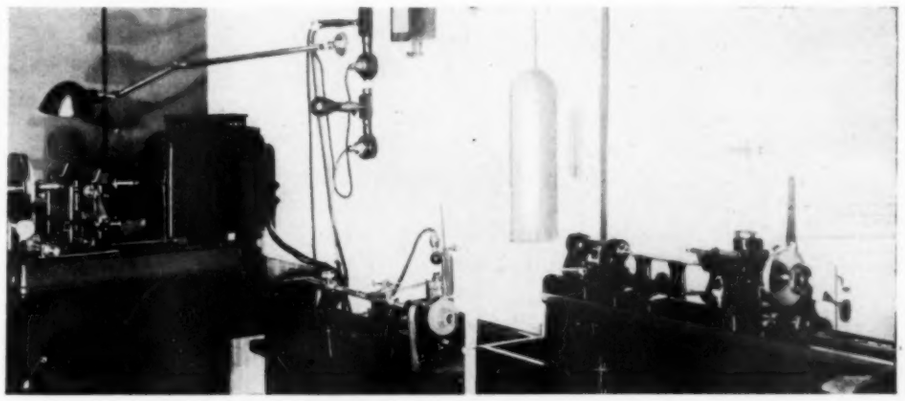
There are in storage approximately 39,000 serviceable gages, the money value of which is estimated to be about $2,300,000.00.

The laboratory is equipped with the latest measuring instruments. Possibly one of our most interesting instruments is the projectograph—an instrument used for the visual inspection of gages. It is a product of the Bureau of Standards, and is an entirely new departure in projectographs, projecting the image on the screen directly in front of the operator. It has a quick change head for determining angles, an adjustable carriage for handling the work, and an amplification of 50-100-250 to 1. It is used for profiles, angles and thread leads. Another interesting instrument is the Bureau of Standards lead tester, for determining the actual variation in the lead or pitch of male and female thread gages. This instrument amplifies about 200 to 1, throwing a light beam across a series of prisms and then onto a screen. It has a graduated head by which a reading may be obtained to the fifth decimal place. There is also an 80-inch Pratt and Whitney comparator for measuring lengths. This instrument reads to the fifth decimal place, using a suspended plug to do away with the sense of touch. One of the late pieces of equipment received is the new Pratt and Whitney Co. super-micrometer—an instrument for measuring to the ten thousandth part of an inch. Other equipment includes vernier calipers, vernier height gages, vernier thread gages, sine bars, measuring bars, measuring balls, measuring disc indicators reading to one ten-thousandth of an inch, and numerous other accurate measuring instruments. The most interesting equipment to many visitors is the standard blocks used as a standard for all measurements. There are two types at Watervliet, namely, the Bureau of Standards type, and the Johansson or Swedish type. There are 81 blocks to a set, in each type. The sets may be obtained for either decimal or millimeter readings, and measurements of one ten-thousandth of an inch can be obtained. By wringing on a plate, two blocks having a difference of .0001-inch, the visitor can take a

straight edge, and by looking at the light, actually see one ten-thousandth part of an inch, which is equivalent to taking a human hair and splitting it into twenty equal parts. This is rather hard to conceive unless actually tried.

At the present time there is only a skeleton organization at the laboratory. In an emergency, this has the necessary equipment for quick expansion, and would become a school for instruction of gage checkers, and would furnish trained personnel to the district offices. Orders placed by the central office for cannon gages, will be either shipped to Watervliet for inspection, or an inspector will be sent to the gage plant concerned.

The gage laboratory is responsible for the acceptance or rejection of all cannon gages. When gages have been inspected and accepted the record cards are sent to Washington, where the accountability is carried, and under whose instructions the gages are distributed either to the district offices, or to the contractors' plants, upon request and under the direction of the district office through the procurement section. If any controversy occurs between a contractor and an inspector, over the correctness of gages, the gages will be sent to the laboratory at Watervliet for inspection and final decision. During the World War most of our inspection gages were designed after the contracts were let, so it became necessary, in the great rush for production, to hire designers outside of the Ordnance Department. To most of these designers gun work was a new problem, and much study was required before the drawings could be made, checked, traced, and sent to the gage factories. The work gages could not be designed until after the manufacturer had laid down his operations. Throughout the war, designs were being constantly changed and gaging operations improved.



Measuring Instruments Used in Gage Laboratory, Watervliet Arsenal.

"In time of peace prepare for an emergency." The gage engineer and designers at the Watervliet laboratory are at work constantly gaging and regaging the various components. All the drawings for the gages shipped to this depot are on file, and with this vast amount of information at hand, the latest and most approved methods and designs are being embodied in new gaging units, both for the guns of present design, and for the new types as they are adopted.

A gage list of master and inspection gages is made up, covering all component parts of a gun, and forwarded to the Gage Section, Office of the Chief of Ordnance for criticism. After corrections have been made and the list approved, the drawings are made and sent to the central office for final approval, after which they are traced, and forwarded to Washington for file, a brown print copy being returned to the laboratory for its file. Thus, in case of another emergency, gages will have been designed and the drawings will be ready to send to the gage manufacturer without delay. With regard to manufacturing gages, all of the operations have been laid down for the various guns. A gage list has been prepared showing the number of gages required for the various operations. The drawings are on hand, and should the contractor see fit to use the Government's method, most of the gages and all of the gage drawings could be furnished without any delay. The magnitude of the work involved can be better appreciated when we take as an example, the 75-mm. gun, model 1897 (French). There are 384 inspection, and 1,044 work gages required for one set. Tracings and prints must be made of each of these gages, involving a close study of the component itself, an intimate knowledge of the tolerance and allowance, the exercise of sound judgment in prescribing gage increments in order to give the manufacturer the benefit of all the tolerances prescribed on the component drawing, and at the same time keep down the cost by allowing a reasonable wear allowance on the gage.

In the illustration, showing one of the components, a "Firing Mechanism Housing" with the necessary inspection and work gages required to produce this part, the piece is a small unit, yet there are 84 gages required in its manufacture.

It is interesting to note the change that has taken place in gages during the last few years. Snap gages were made of a solid drop forging. When a "Go" and "Not Go" size was required, two gages were furnished. If the component size should change, or the gage become worn, it was necessary to send it to the forge shop to have it closed in, or else it was scrapped. Today we use commercial adjustable snap gages, and one gage takes care of both "Go" and "Not Go" sizes. When this gage becomes worn it is readily reset, sealed and put back in production. Plug gages were formerly made solid and when worn were scrapped or reground for a smaller size. Today we have the commercial plug, which is a handle with cylinders that slip on the ends and held in place with a screw. When the end of a cylinder gets worn, it is taken off and reversed, and the gage goes back in production. This same comparison holds good with our thread gages.

It is the policy of the Ordnance Department to use standard commercial gages wherever practicable. This means a big saving in both time and money, as it will be possible to procure about 60 per cent. of the required gages from standard stock.

Editorial

A Body Blow at Industrial Preparedness

THE old favorite—the false logic that the end justifies the means—again comes to the fore in House Joint Resolution 183, known as the Burton Resolution, prohibiting the exportation of arms to belligerent nations, which has met the approval of the House Committee on Foreign Affairs. The formal report of the Committee is extremely interesting. Explaining the resolution as a declaration of policy, the Committee report says, in part:

"The first section of this resolution in unequivocal language, declares it to be the policy of the United States to prohibit the exportation of arms, munitions or implements of war to any nation which is engaged in war with another.

"The second section provides that whenever the President recognizes the existence of war between foreign nations by making the usual proclamation of neutrality, it shall be unlawful, except by the consent of the Congress, to export or attempt to export any arms, munitions or implements of war from any place in the United States or any possession thereof to the territory of either belligerent, or to any place from which the ultimate destination is such territory, or for any military or naval force of a belligerent.

"The third section defines in very considerable detail in 14 subsections what is meant by arms, munitions, or implements of war. This has been thought necessary in order that in the enforcement of the law there may be no ambiguity as to what is included in the prohibition of exportations; also, in order that it may be made clear that other articles not included in the enumeration can be exported without violation of the law.

"While Congress undoubtedly would have the right to suspend or repeal the prohibitions enumerated in the resolution, it is thought best to make specific mention of the fact that 'by the consent of the Congress' the inhibition of the resolution may be removed. This would mean that as to any or all of the belligerents, Congress could remove the prohibition.

"The fourth section specifies the penalty, a fine not exceeding $10,000 and imprisonment not exceeding two years, and imposes upon the Secretary of the Treasury the duty of reporting violations to the United States District Attorney for the district wherein the violation is alleged to have been committed.

"This resolution marks a notably advance step for the prevention of war and the promotion of universal peace. It is certainly a well-known fact that no nation can wage war for any considerable time, or on any large scale, unless implements of warfare can be obtained from neutral nations.

"In every great contest the demand has been made upon the neutral nations for necessary supplies. It has not been thought best to prohibit the exportation of food or articles used alike by the civilian population as well as in the prosecution of war.

"The resolution seeks to harmonize the policy of this country in the furnishing of military supplies to certain regulations pertaining to naval warfare.

"As the United States has taken a leading part in the establishment of beneficial principles of neutrality and has adopted regulations tending to promote peace, it is regarded as of the greatest importance that this resolution should pass.

"It will be a declaration on the part of the United States that we do not desire that our citizens should participate in the profits derived from the furnishing of implements of destruction.

"It is thought also that this will be a restraining influence when nations are about to embark in war, and it is hoped that other countries may, should this become a law, adopt similar regulations.

"There can be no question of the earnest desire of the great body of the American people to promote peace and prevent the horrors of war. Among all pending measures which look to this result, this may be regarded as one of the most salutary and helpful."

In our opinion this proposed law is a body blow at industrial preparedness.

Declaring that the resolution would impair national defense plans and involve the United States in international complications, Hon. Dwight F. Davis, Secretary of War, entered well-taken objection to the passage of the resolution when he appeared before the Committee on March 15th, 1928.

Outlining his views as to the possible effect of the resolution on national defense, Secretary Davis described the dependence placed by the military establishment on private manufacturers of arms and munitions.

"The question of munitions," the witness said, "is the most complex in preparation for war. I am not concerned with the question of profits that will be made out of war, but I desire the Committee to know that the munitions industry is vitally essential to the national defense."

Mr. Davis said there were two ways of supplying munitions—either through private plants or Government arsenals. Congress had indicated that it did not want to provide and maintain Government plants for their manufacture, he pointed out.

"Private manufacture of supplies is regarded as the nonmilitaristic way of preparing for war," continued Mr.

Davis. "Our Government arsenals in the World War supplied only 10 per cent. of our needs. Any step, such as provided in this resolution, which will cripple private industry will correspondingly reduce the effectiveness of our national defense.

"If the Burton Resolution had been in effect in the World War, American participation would have been so reduced that Germany would have won the war."

The potential productive capacity of American munition plants, Secretary Davis explained, could be regarded as a protection for peace, in that foreign nations realized the value of American plants as source of supply. In answering questions of committeemen, Mr. Davis said he had no doubt that the passage of such a resolution would discourage industry and result in drastic curtailment of its facilities.

Both Representative Burton and Representative Moore, of Fairfax, Va., acknowledged that the resolution embodied a new declaration of policy on the part of the United States, but pointed out that, under its terms, Congress could raise the embargo. Such procedure, in event of war, said Mr. Davis, would be regarded as an unfriendly act, by the nations against whom the exports were to be used.

Secretary Davis called attention to the fact that, at the recent arms traffic conference at Geneva, small nations, which do not produce their own war supplies, were opposed to any arrangement that would exclude them from purchase of arms. The Secretary of War said he believed the larger nations would be pleased to have the United States restrict its war preparations by the passage of the resolution.

In answer to a question by Representative Cooper, of Racine, Wis., as to whether the resolution was not a constructive step toward ending war and carrying out the ideals for which the World War was fought, Mr. Davis said:

"If I so regarded it, I would promptly favor it. But I am afraid it will not."

In this contemplated legislation we have the old expedient of attempting to legislate international peace by restricting the manufacture and use of munitions, the same philosophy that would do away with domestic crime by preventing the manufacture and shipment of firearms. It is high time that the error of such logic were well impressed on all.

We have on our statute books a National Defense Act which, if given half a chance, is the best we have ever had. It contemplates a skeleton organization of men and munitions, it places highest importance on the industrial phase of national defense by conceding to American industry the gigantic job of making munitions in war. To impose this obligation and at the same time penalize those who in the fulfillment of it would sell their products to whomever, under international law, could buy, is to impose a burden the weight of which might crush all interest and coöperation. To restrict private enterprise, as the Burton Resolution would, by denying to American citizens the general right to produce and export their manufactures is a serious denial of the prerogatives of citizenship and more, in this case, is a severe handicap to the attainment of our own national defense.

Opinion on the Need for Preparedness

MAJ. GEN. HUNTER LIGGETT, whose name holds high place in the annals of American participation in the World War, is the author of a recent book entitled "A. E. F." In it his entire philosophy of war seems to be epitomized in these words, "As a professional soldier I occupy the middle ground of realism. I have a normal human hatred of war but I know that it can be just and inevitable and that it never can be avoided by pretending not to see it."

Gleaning from the past one can recall that others before General Liggett expressed themselves in similar mood. Washington himself did not spend all the leisure of his retirement in making entries in his cash accounts. Great soldier and statesman that he was, he gives us this gem of reflection on the conduct of human beings: "No sound mind can doubt the essentiality of military science in time of war, any more than the moral certainty that the most pacific policy on the part of a government will not preserve it from being engaged in war more or less frequently." That was as good doctrine a century and a quarter ago as it is today. Coming down more closely to our own day, General Upton, said, "Unless we frame and bequeath to the succeeding generations a military system suggested by our past experience and commended by the example of other enlightened nations, our rulers and legislators in the next war will fall into the same errors and involve the country in the same sacrifices as in the past."

Elihu Root, of our own time, puts it thus, "No sense of justice, no desire for peace, no kindness of heart can turn aside the inexorable decree of the overwhelming powers that bring war and will bring war in the future, as they have brought it in the past. It lies not in the generous impulse of the human heart, but it lies in the working out of the destiny of mankind that no people can avoid." And history seems to point quite definitely to the wisdom of these doctrines.

In a recent issue of *The North American Review*, Maj. Gen. Fox Conner, U. S. A., recalls some interesting historical sidelights on well-intentioned gentlemen whose historical perceptive was not quite as broad as those quoted above. General Conner recalls that in August, 1842, Mr. Edwards, of New Jersey, informed the House of Representatives, "We have no prospect of war. We have more reason to suppose that the world will grow wiser and that the humane and oft-repeated wish of the wise and good that the sword and the bayonet may be converted into the scythe and the plowshare, will be realized." And yet in May, 1846, Congress declared that a state of war existed with Mexico!

And again Mr. Cannon, of Illinois, on April 14, 1896, said in the House, "I want to say that I do not believe we will have war the coming year—no war this year, nor next year, nor the year after. I doubt if there will be any during this century or perhaps the early years of the next century." And not two years after that Mr. Cannon was all for war and, as the *Boston Transcript* puts it, "we entered what was perhaps the worst-prepared-for war of all history."

And so it goes and probably will go always. Many of us live to learn while others seem not to learn to live.

Historical

Smokeless Powder in the United States Army

(Through the courtesy of Columbia University Press, publisher of "History of Explosives Industry in America," by A. P. Van Gelder and Hugo Schlatter, ARMY ORDNANCE *is authorized to reprint Chapter V, Part IV. Due to the length of the chapter it will be published serially in this section. The first section appeared in the January-February, 1928, issue.)*

THE powder submitted by duPont, which was of Belgian manufacture (P. S. duPont) was almost cubical, measuring .055-inch to .065-inch on each edge. It had a pineapple odor and was almost black in color, gave practically no smoke, but some burning grains were ejected from the gun and some unburned grains were found in front of the gun after firing. The results were better than with Wetteren, but not quite so uniform as with Maxim powder, nor were the velocities as high. Walsrode, a well known European powder, for which Schoverling, Daly and Gale of New York were agents, was less satisfactory than either duPont or Maxim.

However, in spite of these promising results, General Benét makes the comment (annual report of 1890) that it cannot be said that these explosives will supersede the present service powders.

In the following year a new variety of Maxim powder containing 74 per cent. guncotton, 25 per cent. nitroglycerin and 1 per cent. castor oil, was tested in comparison with a number of foreign powders. Wetteren, Nobel and Maxim all gave about the same results, whereas an Austrian powder and the French BX powder were less satisfactory, the latter in addition not being entirely smokeless. Another new powder was submitted by W. B. Houghton for Dr. Robert C. Schüpphaus, the inventor. These men had offered their first samples in November, 1890, but they were not satisfactory. Being made acquainted with the requirements of the Army, they gradually improved their powder, until samples tested in March, 1891, brought forth the comment that "they were inferior to none, superior to the great majority." The grains were dark brown cubes, .05-inch on edge, soft, and gave no smoke, no odor, and barely a trace of fouling on firing. With a 32-grain charge a velocity of 1966.5 f. s. was obtained with an average pressure of 50,585 pounds.

The report of the Chief of Ordnance for this year (1891) also contains, as an appendix, a translation of a description of Nobel's smokeless powder (ballistite) from the *Berlin Post* of September 30, 1890, which is interesting chiefly because it mentions the use of diphenylamine as a stabilizer, which was not adopted in this country until 1908.

At this time the influence of size and shape of smokeless powders on their performance in different guns was apparently not realized, which seems surprising in view of the fact that Major Mordecai and General Rodman had pointed out as early as 1846 and 1858 that large grains of black powder were better adapted to heavy guns than fine grained powder, and that the Ordnance Department was definitely committed to the policy of special granulations of black and brown powder for different guns. More systematic work, however, was being instituted, for in 1892 it is reported that "the granulation of powders is being investigated and that Captain Pitman has been assigned to organize and conduct a chemical laboratory at the Frankford Arsenal."

On the other hand, coöperation with the Navy was sadly lacking. The latter had made some progress with the development of a smokeless powder of its own, but the Army seemed unable to procure a sample of this powder for testing. The two branches of the service pursued their separate ways for a number of years more, until an accident with the nitroglycerin powder adopted by the Army led them to change to a nitrocellulose powder similar to that of the Navy, and even then the specifications differed slightly until a joint board, appointed in 1905, issued joint specifications in 1910.

In 1893 samples of Peyton, Leonard, duPont, Axtell, Alters, and U. S. powders were tested in the rifle, besides a variety of powders for foreign manufacture. The Leonard and Peyton powders gave superior results. The Chief of Ordnance reported that the proprietors of these powders were encouraged to proceed with the manufacture in quantities. The duPont powder, which was made in the same manner as their shotgun powder, was reddish brown in color, very small and regular, gave excellent uniformity with a black powder primer, but the pressures were too high and the velocities too low. The powder submitted by F. C. Axtell of New York, who was a celluloid man and later built a celluloid plant in Japan, was like curled hair in appearance. That of Frank C. Alters of New Home, Arkansas, was of the semi-smokeless type; it resembled iron filings and was granulated like a mealed powder. The velocities of both Axtell and Alters powders were entirely too low. The PPG powder made by Lieut. Willoughby Walke of the Artillery was said to be a mixture of nitroglycerin and nitrocellulose which was not guncotton but a specially prepared compound. It was claimed to contain less nitroglycerin than Leonard powder and gave good results, but Lieut. Walke was never able to duplicate it. The "U. S." powder which was tested at Leonard's request was made by the U. S. Smokeless Powder Company of California and consisted largely of ammonium picrate, being in the form of small cylinders of yellow color. This company continued to submit samples for several years

(until 1897), but the powder was found to be dangerous, as it burned slowly only until a certain critical pressure was reached, above which the combustion took on an explosive character. Furthermore, the powder was hygroscopic and friable and on firing gave off a very disagreeable odor.

On November 4, 1894, the Army invited bids on 10,000 pounds of smokeless powder for the caliber .30 rifle and issued the first set of specifications in connection therewith. In view of the uncertainty as to the type of smokeless powder desired, the specifications were general in terms. Neither composition nor charge was specified, only the dimensions of the cartridge case and bullet. A velocity of 1960 f. s. at 53 feet was desired with a mean variation of 20 f. s. in 40 rounds and a maximum pressure of 38,000 lbs. per sq. in. A number of tests were prescribed to determine the influence of atmospheric conditions, moisture, heat, and cold on the performance of the powder. It was further required that the powder be uniform in quality, free from dust and other foreign matter, and practically smokeless; that it must not corrode the barrel or cartridge case, require an unduly strong primer, or leave a hard adherent residue in the barrel; that it must not be sensitive to friction or shock, or be so friable as to break up in transportation; that it must not contain ingredients known to be unsuited to form a safe and reasonably stable compound, and that it must admit of machine loading with a variation of not over 3/10 of a grain in 50 consecutive loads. It was also stated as desirable that it should not give excessive heating in rapid fire. Preference was to be given to powder of American manufacture, as well as to one not containing nitroglycerin. As both the California Powder Works and the Leonard Smokeless Powder Company had previously submitted promising samples and seemed to be equipped to start manufacture, the contract was divided equally between them. The former delivered its share in good season early in 1894 and was given an additional order for 10,000 pounds; the latter had difficulties in manufacturing and did not complete deliveries until the first of 1895.

Numerous other samples of smokeless powder for small arms were submitted during these years; for instance, in the fiscal year ending June 30, 1894, Frankford Arsenal examined 25 varieties. The Giant Powder Company offered samples at Benicia Arsenal which gave promising results, but never passed the experimental stage and in 1897 this company gave up all ideas of going into this business. Albert Smith of New York, H. P. Weidig of New Jersey, Frank Neidl of California, Lawrence, Volney, Maxim and Schüpphaus, Whistler and Aspinwall, the Savage Repeating Arms Company, and others submitted powders with results that were, as the Chief of Ordnance puts it (Report of 1895), in most cases "useful only to the makers." Up to June, 1895, the Peyton powder made by the California Powder Works was chiefly used in the service ammunition for the magazine rifle, with some deliveries from the Leonard (or American) Smokeless Powder Company. After that the duPont company also furnished considerable amounts, and about 1898 the W-A powder of the Laflin & Rand Powder Company, which had absorbed the American Smokeless Powder Company, became a strong competitor on account of the excellent ballistics obtained, although it produced comparatively high erosion. However, powder of this type (W. A. caliber .30 powder), containing 30 per cent. of nitroglycerin, remained the standard service powder for small arms until 1908 when the present straight nitrocellulose (caliber .30 pyrocellulose) powder was adopted under the specifications of April 18, 1908. These specifications not only prescribed the composition of the powder, but gave detailed directions as to methods of manufacture to be used, whereas previous specifications for nitroglycerin powders had left these points to the discretion of the manufacturers and specified only the tests the finished powder had to meet.

While progress was thus being made with the procurement of rifle powder, developments with cannon powder were not so satisfactory. In 1894 only one sample of smokeless cannon powder of American origin (Leonard's Ruby powder containing linseed oil) was submitted, as against 25 varieties of small arms powder. Of course, the Army was primarily interested in the latter, as it was absolutely necessary for the new magazine rifle; but seacoast and field guns also had to be provided with smokeless powder. The California Powder Works, the duPont company, the Leonard company, and the Maxim Powder and Torpedo Company responded to an invitation to bid on experimental cannon powders. These were delivered in the course of the next year and were tested in comparison with German powder from Troisdorf and Rottweil. With the exception of the duPont and Troisdorf powders, they all contained nitroglycerin, to which objection had been frequently made by Ordnance officers on account of the greater erosion of the gun barrels due to these powders. The Maxim-Schüpphaus powder was in the form of perforated cylinders, and the Chief of Ordnance comments (Report of 1895) as follows: "To the makers of this powder is due the credit for reviving in this very successful application this old principle, first enunciated, I believe, by General Rodman." In issuing specifications for smokeless powder for special tests in the 3.2-inch breech-loading field gun in November, 1895, it was stated that the types of powder wanted were (1) a powder same as the Peyton powder for cannon recently tested by the Department, (2) one same as the Maxim-Schüpphaus powder for cannon recently tested by the Department, (3) a plain guncotton powder without nitroglycerin, and (4) a powder having essentially the composition, 75 per cent. low-grade nitrocellulose and 25 per cent. nitroglycerin. The comparative tests carried out with these powders (to which one designated as Whistler-Aspinwall XX had been added) were not conclusive, and in January, 1897, a new set of samples was ordered. Besides the Peyton and Whistler-Aspinwall powders, the following compositions were specified:

XX (11.0-40) containing nitrocellulose of 11 per cent. N and 40 per cent. nitroglycerin; XX (12.0-25) containing nitrocellulose of 12 per cent. N and 25 per cent. nitroglycerin; XX (13.0-10) containing nitrocellulose of 13 per cent. N and 10 per cent. nitroglycerin; and the best Rottweil powder was ordered from the American Ordnance Company for comparison. As a result of these trials a seven-perforated cylinder of the formula XX (12.0-25) was adopted as the most suitable smokeless powder for cannon. The contracts for these special powders had left granulation to the manufacturers, only specifying that it must be "suitable to give the best practicable ballistic results without unnecessary waste of charge." On the other hand, a heat test with KI-starch paper of 20 minutes at 150-154° F. had been included.

(To be Continued)

Professional

"New Methods in Exterior Ballistics"

IN THE March-April, 1927 (Vol. VII, No. 41), issue of this journal Mr. R. H. Kent made some comments on my recent book, "New Methods in Exterior Ballistics," which, I think, are based on misconceptions respecting the facts. I should like to straighten out a point or two in order that those who have not had the time to make a thorough study of the subject should not be misled.

In the same number Mr. Roger Sherman Hoar writes a review which is remarkable for its superlatives respecting things which I consider of minor importance, and which is critical of things which he apparently does not understand. I should like the privilege, also, of making some comments on this review.

Perhaps I should answer first Mr. Kent's statement that my failure to make frequent reference to earlier workers in the field conceals the debt I owe them. The fact is that beyond the differential equations themselves, which are written down immediately from Newton's laws of motion, I borrowed nothing whatever so far as I know, either direct or indirect, that was not explicitly referred to in the text. The methods of most earlier writers were wholly inadequate for the problem, and many of them contained errors. In a history of the subject it would be quite proper to describe them, but my task was a much more limited one to which I held myself. I referred to the work of Fowler, Gallop, Lock, and Richmond only casually because I did not make any use of their work, and not a line of mine was influenced by theirs.

The most important thing in Mr. Kent's remarks is that he thinks I should have given more heed to the work of Fowler and his associates. More explicitly, Mr. Kent thinks my methods do not take into account what he calls the "cross-wind force," and that this force is very important.

So far as the methods are concerned, it will be found that they can be easily extended to take into account all the facts whatever they may be. In the last section of the book I outlined how the extensions may be made, and I referred to a mathematical paper that I published in 1912 which gives all necessary details for treating the differential equations in any extended case. Further proof that the methods include a cross force lies in the fact that gravity is a cross force which I treated in detail. Consequently, I repeat that the methods I used are applicable to any case.

Now, if the "cross-wind force" is as important as Mr. Kent says it is, then I made a tactical blunder in exposition by first giving details with it explicitly neglected. In fact, as I think of it now, I believe I made a tactical mistake in giving a simple physical interpretation of the moments of forces which I used. This interpretation was introduced to give the problem a concreteness that it might not otherwise have. I was stimulated to do this because when I entered the Army those who were working in ballistics were engaged in prolonged discussions respecting such simple questions as whether a head wind would increase or decrease the maximum ordinate of a projectile. In these discussions and memoranda moving axes and similar things were introduced to get a physical picture expressed in terms of one syllable. Now the physical illustration I gave corresponded to the equations I used, but the equations had an origin resting on more fundamental properties of the problem. As I explained in the last article in the book, the moment in the plane of yaw is a function of the angle of the yaw which can be expressed as a Fourier series. Since the function is odd, it is a *sine* series. This is true whether or not there is a "cross-wind force"; such forces are included in what I have called X, Y, Z. These forces curve the trajectory, and, on page 241, I have given two methods of taking the curvature into account.

I now raise a question of fact. Mr. Kent says, "In fact, the contribution of the cross-wind force to the overturning couple is about ten times the contribution of the head resistance." In spite of my high regard for Mr. Kent's judgment respecting physical things, which I acquired during our close and cordial relations in Washington in 1918, I cannot accept this conclusion without very much more evidence in support of it than I have had. The evidence presented by the curves he has drawn to interpret his experiments is in my opinion very inconclusive. Generally speaking, he has a few points on curves with as many waves as he has points. I think I can easily mention a score of abandoned physical theories that were once believed to be true on what was better evidence.

But I do not wish to base my doubts on the grounds of inconclusive evidence. Note that he states that the couple due to the cross-wind force is about ten times that due to the head resistance. The former of the two couples is the cross-wind force times the *cosine* of the yaw; the latter is the head force times the *sine* of the yaw. But since both couples are odd functions of the yaw, the former is a force times the *sine* of the yaw times the *cosine* of the yaw, or a force times the *sine* of twice the yaw. That is, the cross-wind force vanishes with the yaw while the head force does not. If R represents the head resistance, Θ the yaw, and $C \sin \Theta$ the cross-wind force, then what Mr. Kent says is that

$$C \sin \Theta \cos \Theta = 10\ R \sin \Theta;$$

or,

$$C \sin \Theta = 10\ R \tan \Theta$$

If this couple be added to the force system, the differential equations may be treated by the method I outlined in Art. 63 of my book.

The left member of the foregoing equation is the cross-wind force and R is the head resistance. If $10 \tan \Theta$ is greater than unity, the cross-wind force is greater than the head resistance. This relation exists if $\Theta > 5^\circ\ 43'$. If

$\theta = 2°$, the cross-wind force is more than one-third the head resistance; if $\theta = 1°$, the cross-wind force is more than one-sixth the head resistance. An angle of yaw from 2° to 6° is common. Consequently, what Mr. Kent says is that the cross-wind force is often from one-half to one and one-tenth the head resistance.

We may think of the projectile as being held fast and a blast of air blowing on it a little obliquely, and then consider the forces impressed upon it. This corresponds to what is done in wind-tunnel experiments. The molecules encounter the projectile or other molecules packed up on the projectile. There are two extremes conceivable. One is that in which the molecules rebound from the projectile like perfectly elastic bodies. The other is that in which they have no elasticity whatever. In the former case the cross-wind force would be the greatest possible; in the latter it would be zero. Now there is no difficulty except some integral calculus in computing the former. Unless it should be found greatly to exceed the 10 R tan θ, the statement of Mr. Kent is erroneous, for the atmospheric molecules by no means rebound from a projectile as perfectly elastic bodies. In fact, photographs of projectiles and fragments of projectiles travelling at a velocity exceeding that of sound indicate that the air packs up ahead of a projectile or fragment however it may be oriented almost as though there were nothing resembling an elastic rebound. That is, the photographic evidence is directly contrary to the statement of Mr. Kent.

It was remarked that wind-tunnel experiments would bear upon this question. Dr. Hull and Dr. Briggs made experiments at Lynn, Mass., for the purpose of answering this question. Unfortunately, the experiments at velocities beyond the velocity of sound are extraordinarily difficult and they do not regard their results as conclusive. But so far as they go they indicate that the cross-wind force is only a fraction of the head resistance instead of being comparable with it.

Finally, consider, for example, a three-inch projectile after it has reached its maximum ordinate, say of 2,000 yards. The head resistance will be comparable to gravity. At this stage the projectile will have arrived at an approximately steady state with the nose to the right of the plane of the trajectory and a nearly constant yaw. Suppose Mr. Kent is right and that the cross-wind force is, say, one-half the head resistance, which, under the hypotheses, is one-half gravity. Gravity pulls the projectile down 2,000 yards. Hence the cross-wind force should move it to the right 1,000 yards. But it does not.

To recapitulate: My methods will treat any case. If Mr. Kent should be right respecting the magnitude of the cross-wind force, then the results I worked out in full detail do not sufficiently approximate the actual facts, but would require the modifications I have shown how to make in Art. 63.

THE remarks of Mr. Hoar are of quite another character.

One of the grievances of Mr. Hoar is that I did not use slight variations from my original notations that were "officially" adopted by a three-cornered correspondence, nor did I use a left-handed set of axes. Now it is a fine thing to adopt "officially" some notations including left-hand axes. But this official action is not binding on civilians, and I am a civilian. Nor is it binding on foreigners. Nor is it binding on the Navy. In fact, if the Navy should ever hear of it, they would adopt something else, and, I hope, a right-handed system of axes. Nor will it be binding on the Army in the future, for some day enthusiastic young officers, eager to make any sacrifice for their country, will show their independence of mind and make modifications in these "official" notations, just as the gentlemen to whom Mr. Hoar refers modified my official notations. I cannot get warmed up on so trivial a matter.

There are statements in Mr. Hoar's remarks which indicate that, so far as he is concerned, I overshot the target. He says "the book merely mentions the Bliss part of this development," referring to the work of Professor Bliss in using the adjoint system for computing differential corrections. Here are the facts. In my first paper, written shortly after I entered the service, I seized the problem of computing differential variations and pulled it out of the fogs in which it was involved and placed it on a solid foundation. About six months later Professor Bliss introduced the adjoint system for use for particular limited purposes. In my book I have given a complete and explicit account of the work of Professor Bliss. He read the manuscript and the proofs and agreed that it was a complete and correct exposition of his work, and he also passed as correct my statement of the limitations to which the method is subject. Apparently Mr. Hoar did not grasp the purport of what preceded the discussion of the work of Professor Bliss, and he could not realize that the subject could be completely treated in one article.

That Mr. Hoar did not connect with the essence of the chapter on Differential Variations, which is based on a use of fundamental sets of solutions, is proved by another remark that he made. He complains that I did not use the curved surface of the earth as a reference line. If I had been interested in isolated trajectories I might have done so, though I think it would have been very inadvisable to do so. But I was interested in families of trajectories and their variations, and to have used the curved surface of the earth as a reference line would have sacrificed all the powerful machinery I built up, based on the use of fundamental sets of solutions. To have done this would have been inexcusably stupid.

Mr. Hoar says that the book he got out in 1921 for use in instruction at the proving grounds is considerably more up to date than my book. Inasmuch as about half the material in my book, including the most important and most difficult parts, are not even referred to directly or indirectly in Mr. Hoar's book, this is a remarkable statement. In particular, such things as proving the validity of the methods employed, the use of fundamental sets of solutions of systems of linear differential equations, and the dynamics of rotating projectiles, which cost me more work than everything else combined, are apparently completely beyond his horizon.

F. R. MOULTON.

Elements of Gunnery

WITH the introduction of rifled cannon during the second half of the nineteenth century, range and accuracy of guns were increased enormously, the development of high explosives likewise increasing the effect of projectiles. Toward the end of the nineteenth century progress in fire-

control methods and in accuracy was such as to permit the development of gunfire at moving naval targets with considerable accuracy. During the World War, as a result of the use of airplanes, gunfire at targets moving in three dimensions was developed.

In less than fifty years there has been a development from a stage where firing at a fixed target a short distance away was considered to be the height of usefulness of guns, to a stage where an airplane moving in three dimensions can fire on a target moving in three dimensions with some hope of effect. The cycle in the development of the throwing of projectiles by gunfire may therefore be considered to be almost completed.

At present targets moving in three dimensions cannot be hit with the success that is desirable, nor can guns moving in three dimensions shoot with the accuracy that is desirable. Three dimensional gun and target problems are far more difficult to solve than either one or two dimensional problems. But the essentials of all gunfire are similar, and it is probable that the accuracy and effect in three dimensions will in a short time be increased up to the desired point, provided the proper ballistic and fire-control studies are made.

The following outline gives a sketch of the relative amounts and kinds of data, methods of adjustment of fire, and accuracy of most of the kinds of gunfire and projectile throwing. The outline begins with the simplest case of a fixed gun firing at a fixed target and proceeds to the most difficult case of one airplane firing at another airplane. A study of this outline or an elaboration of it, should help in obtaining qualitative answers to such questions as the Ordnance Department was asked to answer during 1926, relative to the comparative accuracy of bombers, antiaircraft, and seacoast guns.

A. I *Fixed Gun at Fixed Target:*
- a. Types:
  - (1) Small arm at fixed personnel;
  - (2) Artillery fire at fixed personnel or matériel;
  - (3) Coast defense gun fire at anchored ship or vice versa.
- b. Data required for setting sights:
  - (1) Range;
  - (2) Direction.
- c. Method of adjustment:
  - (1) Ballistic preparation;
  - (2) Registration or trial shots;
  - (3) Correction as a result of observation of fire from ground, ship's top, other ship, airplane, captive balloon.
- d. Accuracy:
  - (1) Considerable accuracy attainable if sufficient time allowed.

II *Fixed Gun at Target Moving in Two Dimensions:*
- a. Types:
  - (1) Small arm or machine gun at moving personnel, cavalry or tanks;
  - (2) Artillery fire at moving ship;
  - (3) Artillery fire at moving tanks;
  - (4) Moving barrage.
- b. Data required for setting sights:
  - (1) Range;
  - (2) Direction;
  - (3) Angular travel in horizontal plane in unit time.
- c. Method of adjustment:
  - (1) Ballistic preparation;
  - (2) Registration or trial shots;
  - (3) Correction as a result of observation of fire from ground, airplane, underwater.
- d. Accuracy:
  - (1) Important because time is usually short.

III *Fixed Gun at Target Moving in Three Dimensions:*
- a. Types:
  - (1) Antiaircraft gun and machine gun fire at airplanes and dirigibles;
  - (2) Searchlight beam thrown on airplanes and dirigibles;
  - (3) Shotgun fire at birds.
- b. Data required for setting sights:
  - (1) Range or altitude;
  - (2) Angular height;
  - (3) Direction;
  - (4) Angular speed in horizontal plane;
  - (5) Angular speed in vertical plane;
  - (6) Estimations used in shooting at birds.
- c. Method of adjustment:
  - (1) Registration or trial shots for 3-inch guns and searchlights;
  - (2) Correction as a result of observation of fire not yet satisfactorily developed for 3-inch antiaircraft guns;
  - (3) Tracer ammunition with aid of sights now under development.
- d. Accuracy:
  - (1) Fair with carefully determined data for 3-inch antiaircraft guns;
  - (2) Hits a matter of luck and dispersion in antiaircraft machine gun fire;
  - (3) Very little for searchlights until fire-control system using sound locators is satisfactorily developed.

B. I *Gun Moving in Two Dimensions at Fixed Target:*
- a. Types:
  - (1) Moving ship's fire at shore defense;
  - (2) Tanks or armored car at personnel;
  - (3) Cavalry at personnel.
- b. Data required for setting sights:
  - (1) Range;
  - (2) Direction;
  - (3) Angular speed in horizontal plane;
  - (4) Ship must eliminate or correct for pitch and roll.
- c. Method of adjustment:
  - (1) Practically no preparation;
  - (2) Correction as a result of observation of fire from ship's top, other ships, airplane;
  - (3) Tanks and cavalry have practically no methods of adjustment.
- d. Accuracy:
  - (1) Relatively small;
  - (2) Ship depends for effect principally on volume of fire.

II *Gun Moving in Two Dimensions at Target Moving in Two Dimensions:*
- a. Types:
  - (1) Ship's fire at other ships;
  - (2) Tank's fire at other tanks;

(3) Cavalry fire at moving personnel.

b. Data required for setting sights:
(1) Range;
(2) Direction;
(3) Angular speed of target in horizontal plane;
(4) Angular speed of gun in horizontal plane;
(5) Ship must correct for or eliminate effect of pitch and roll.

c. Method of adjustment:
(1) Practically no preparation of fire;
(2) Ship may adjust by observing fire from top or airplane.

d. Accuracy:
(1) Of ship relatively small depending for effect on volume;
(2) Tanks and cavalry have little accuracy except at short ranges.

III *Gun Moving in Two Dimensions at Target Moving in Three Dimensions:*

a. Types:
(1) Ship's or tank's fire at airplanes and dirigibles;
(2) Ship's fire at submarines.

b. Data required for setting sights:
(1) Range or altitude;
(2) Direction;
(3) Angular height;
(4) Angular speed in horizontal plane;
(5) Angular speed in vertical plane.

c. Method of adjustment:
(1) Registration or trial shots;
(2) Correction as a result of observation of fire very difficult.

d. Accuracy:
(1) Very small, depending on dispersion for hits.

C. I *Gun Moving in Three Dimensions at Fixed Target:*

a. Types:
(1) Attack plane machine gun fire at ground personnel;
(2) Airplane and dirigible attack by bombing ground personnel and matériel.

b. Data required for setting sights:
(1) Altitude;
(2) Angular depression;
(3) Direction;
(4) Angular speed in vertical plane;
(5) Angular speed in horizontal plane.

c. Method of adjustment:
(1) Registration or trial shots not possible ordinarily;
(2) One airplane may adjust as a result of observation of bombing by another plane in same or in different formations;
(3) By flying over undefended target several times correction as a result of observation of first flights is possible;
(4) Ordinarily (2) and (3) not possible.

d. Accuracy:
(1) Against small targets poor, against large targets good.

II *Gun Moving in Three Dimensions at Target Moving in Two Dimensions:*

a. Types:
(1) Airplane bombing of ships and tanks;
(2) Submarine fire at ships.

b. Data required for setting sights:
(1) Altitude;
(2) Angular depression;
(3) Direction;
(4) Angular speed in vertical plane;
(5) Angular speed in horizontal plane.

c. Method of adjustment:
(1) Registration or trial shots impossible ordinarily;
(2) Correction except for excessive deviations impossible.

d. Accuracy:
(1) Volume depended on for effect because accuracy so poor.

III *Gun Moving in Three Dimensions at Target Moving in Three Dimensions:*

a. Types:
(1) Airplane at airplane, dirigible or submarine.

b. Data required for setting sights:
(1) Data, because short range direct fire, not needed.

c. Method of adjustment:
(1) None.

d. Accuracy:
(1) Depends on experience and skill.

PHILIP SCHWARTZ,
1st Lieut., Ord. Dept., U. S. A., Fort Bragg, N. C.

3-Inch Antiaircraft Gun Adopted as Standard for U. S. Army

THE War Department has adopted and approved as standard for manufacture and issue the new 3-inch antiaircraft gun and mobile mount

The 3-inch antiaircraft mobile mount (T-1) is the latest design of mobile and antiaircraft artillery produced by the Ordnance Department, and represents a marked advance over previous types. The questions of stability, mobility and maneuverability are of the greatest importance in a mobile gun carriage, and all three of these points appear to have been successfully accounted for in this carriage. The carriage is stable under all conditions of firing; it may be emplaced from the traveling position in readiness to fire in about fifteen minutes, and is so light in weight that it can be towed across country by a standard four-wheel-drive truck.

The gun is 50 calibers in length and is made up of two parts; an outer tube and an inner removable liner. The removable liner represents a marked advance in gun construction, as it does away with the necessity for sending a worn-out gun to an arsenal for retubing. The cost of the liner is a small fraction of the cost of a new gun, and it can be installed at the firing front in a few minutes by battery personnel using simple hand tools. The use of loose liners in antiaircraft guns is of the greatest importance since it reduces the importance of the question of gun erosion, and thereby permits the use of higher muzzle velocities.

The gun fires a standard 3-inch projectile at a muzzle velocity of 2600 feet per second. The vertical range is about 5,000 yards and the maximum horizontal range 11,000 yards. The gun is equipped with a semiautomatic breech mechanism which closes when the round is pushed home, and opens automatically and ejects the case when the gun is fired.

Association Affairs

Officers and Directors, Army Ordnance Association, Hold Annual Meeting

THE regular annual meeting of the Board of Directors, Army Ordnance Association, was held in New York, February 16, 1928, at the offices of the Treasurer, Col. Chas. Elliot Warren, Vice-President, American Exchange Irving Trust Company, Park Avenue and 42nd Street. Hon. Benedict Crowell, President of the Association, presided. Major General C. C. Williams, U. S. A., Chief of Ordnance, was present by invitation of the Board.

Before proceeding to the transaction of business, Mr. Crowell expressed the regret of the Board upon the death, on June 14, 1927, of Gen. Guy E. Tripp, Chairman of the Westinghouse Electric and Manufacturing Company, who served as a Director of the Association since its establishment in 1919, and as Vice-President since January, 1925. This was the first formal meeting of the Board since General Tripp's death. Mr. Crowell paid high tribute to General Tripp, recalling his untiring interest in all Association affairs, the part he took in establishing the organization nine years ago, and his continued coöperation at all times in matters of industrial preparedness.

The first business before the meeting was the presentation of the annual report of the Secretary for the calendar year 1927. The report reviewed in detail the activities of the Association during the past year. Membership continued to increase, the net gain for the year being 613. The gross increase was 978 while 365 old members, by resignation, death and non-payment of dues, were dropped from the roster. The total membership, all classes, as of December 31, 1927, was 3,253.

During the year two new local posts were organized and chartered: the St. Louis Post established January 18, 1927, with a membership of 129; the Pittsburgh Post organized February 24, 1927, with a membership of 158. The Association now has nine local posts including, in addition to those of St. Louis and Pittsburgh, New York (membership 268), California (membership 120), Chicago (membership 84), Boston (membership 101), Washington (membership 69), Cincinnati (membership 93), and Philadelphia (membership 225). The total number of members affiliated with local posts is 1,247 or approximately 38 per cent. of the total Association membership.

Efforts are being made to establish additional local posts in industrial centers where conditions would seem to warrant them and where interest would assure their success. Activities of local posts during 1927 gave tremendous impetus to interest in ordnance matters generally. Undoubtedly to the Officers and Directors of these local organizations and to their members much of the recent growth of the Association is due.

The Ninth Annual Meeting of the Army Ordnance Association was held at the Aberdeen Proving Ground, Thursday, October 6th, with the Society of Automotive Engineers, the American Society for Testing Materials, and the Military Order of the World War participating. Approximately 20,000 preliminary announcements and invitations were sent to members of the participating associations and to other selected names which resulted in the largest attendance ever recorded. The number present was estimated conservatively at 6,000.

As in 1926, in addition to the preliminary program a final program also was printed and distributed among the guests at the meeting. The tremendous success of the Ninth Annual Meeting may be attributed in large part to the splendid coöperation and support given by the Secretary of War personally and the Assistant Secretaries of War, the Quartermaster General, the Chief of Ordnance, the Commanding Officer of Aberdeen Proving Ground and his staff, and the various chiefs of branches of the War Department whose organizations participated in the various demonstrations.

Attendance at the annual meeting has been increasing at the rate of perhaps 10 or 15 per cent. per year until the last meeting when it practically doubled. While it was realized two or three days in advance of the meeting that an unexpected increase would appear, the full amount of the increase came as a complete surprise and many of the service features connected with the demonstration suffered in quality accordingly. To avoid repetition of the unsatisfactory conditions, complete studies have already been made of next year's plans so that much better service will be given.

The Secretary's report showed the Association to be in sound financial condition. An audit of the finances of the Association, under the direction of Col. Lester W. Blyth, Chairman of the Auditing Committee, was made by Messrs. Ernst and Ernst, certified public accountants, as of December 31, 1927. The accounts were found to be correct and in good order. The balance sheet as approved by Messrs. Ernst and Ernst follows:

Assets

Cash on hand	$ 21.48
Cash on deposit	11,666.10
Accounts receivable	270.00
Securities owned	15,196.91*
Postage	39.15
Furniture and fixtures	1.00
	$ 27,194.64

Liabilities

Unearned Income:	
Prepaid membership dues	$ 7,982.76
Prepaid subscriptions	626.72
Operating reserve	18,585.16
	$ 27,194.64

*Cost. Market value December 31, 1927, $15,836.25.

The report also included a budget of expected income and expenditures for the year 1928 which was approved. In concluding his report the Secretary took occasion to express his appreciation of the counsel and assistance given by all Officers and Directors during the past year and to make grateful acknowledgment of the active coöperation given at all times by officers of the War Department and especially by Maj. Gen. C. C. Williams, Chief of Ordnance, and the members of his staff, and the Commanding Officer of Aberdeen Proving Ground, Lt. Col. C. M. Wesson, and his assistants.

The Treasurer, Colonel Warren, submitted a report of the bank balances and invested securities of the Association.

The following resolution was offered by President Crowell and was adopted:

WHEREAS due to the untimely death on June 14, 1927, of Gen. Guy E. Tripp, Vice-President of the Army Ordnance Association, the office of Second Vice-President is now vacant, and,

WHEREAS by virtue of Article V, Section 4, this Board has the power "to fill casual vacancies by appointment for the unexpired terms thereof in the offices of President, Vice-President, and in the roster of Directors,"

RESOLVED that Col. William C. Spruance, now a Director, is hereby appointed a Vice-President for the unexpired term of General Tripp; namely, until December 31, 1928, and Col. Pliny E. Holt, of Stockton, Calif., is appointed a Director to fill the vacancy thus caused in the roster of Directors.

Upon motion of Col. Robert P. Lamont, the following resolution was presented and adopted:

WHEREAS it is customary for this Board at its annual meeting to fix a date in October for the Annual Meeting of the Association in which certain national organizations are invited to participate, be it

RESOLVED that the Tenth Annual Meeting of the Army Ordnance Association be held, with the approval of the Secretary of War, at the Aberdeen Proving Ground, Maryland, on Thursday, October 4, 1928, and that the following organizations be invited to participate: The American Society of Mechanical Engineers, The American Institute of Electrical Engineers, The Society of Military Surgeons of the United States, and the Construction Division Association.

It was moved by Col. James L. Walsh that the Army Ordnance Association endorse the three recommendations of the Committee on Industrial Preparedness of the National Association of Manufacturers as contained in the Preliminary Report of their First Meeting held in New York City December 15, 1926. This motion was passed and the Secretary directed to publish this endorsement in ARMY ORDNANCE and notify the chairmen of the proper committees of Congress of the action. (The recommendations of the Committee on Industrial Preparedness were as follows:

(1) That the National Association of Manufacturers endorse the organization of the proposed "Munitions Battalion" as described by the Honorable Hanford MacNider, the Assistant Secretary of War, at the Annual Meeting of the Association held in New York City on October 7, 1926; that the necessary appropriation of Federal funds for the purpose of training annually four hundred college students, who have satisfactorily completed at least three years of their courses, in the elements of military science and tactics, and in addition in the basic procurement problems of the Army, be urged upon the Congress now in session; and that, due to the need for immediate action in the premises, Honorable Frank A. Scott, during the war Chairman of the War Industries Board, be requested, subject to the approval by your Board of Directors, to present to the President of the United States the recommendations of the Association in this connection.

(2) That the Ordnance Department of the United States Army be progressively increased over a period of years, in order to provide personnel of a proper degree of permanency equipped with the vitally important knowledge of the design and manufacture of ordnance, necessary to permit present plans for Industrial Preparedness to be carried to a successful conclusion.

(3) That the provisions of Sec. 5a of the National Defense Act approved June 3, 1916, as amended by the Act of June 4, 1920, to the effect that "He (the Assistant Secretary of War) shall cause to be manufactured or produced at the Government arsenals or Government-owned factories of the United States, all such supplies or articles needed by the War Department as said arsenals or Government-owned factories are capable of manufacturing or producing upon an economical basis," be rescinded and that legislation be secured permitting the placing of "educational orders" with commercial manufacturers for the production of non-commercial articles of ordnance with due consideration for knowledge of the art required rather than as at present, upon a competitive basis as to price.)

These recommendations, in accordance with the above motion, were forwarded to the Chairmen of the Military Affairs Committees of the United States Senate and the United States House of Representatives.

There was referred to the Secretary for such action as he deemed proper a letter, dated February 14th, with its enclosures from the United Engineering Society requesting coöperation and participation of the Army Ordnance Association in a movement toward a Louvain Memorial to American engineers.

There being no further business, the meeting was adjourned sine die.

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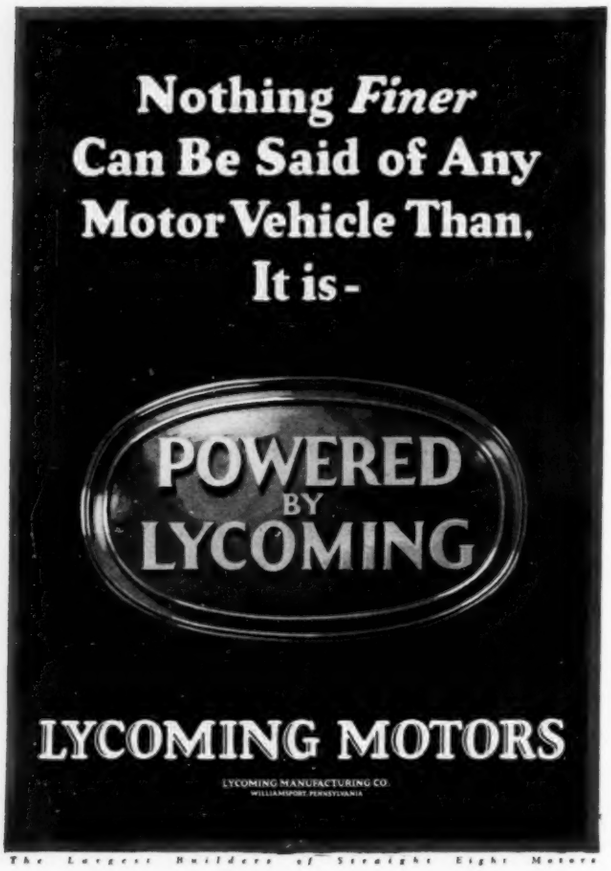

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BROOKLYN NEW YORK

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Philadelphia Post, A. O. A., Meeting

THE Philadelphia Post of the Army Ordnance Association had its fall meeting at the Engineers' Club, Philadelphia, November 7, 1927, with a large attendance. The local sections of American Society for Testing Materials and Society of Automotive Engineers were invited to participate in this meeting to review a number of the incidents and to discuss new Ordnance matériel which was displayed at the Aberdeen Proving Ground at the annual meeting of the Army Ordnance Association.

Lt. Col. Joseph A. Steinmetz, Spec. Res. president of the Post, presided.

The first speaker was Col. George L. Wall, Commanding Officer at Frankford Arsenal, who gave a talk on his experiences in the Philippine Islands. The sincerity with which he told of the human side of life there, and his observations on the historical and political side of the Philippines, were of deep interest to all members present. It was the first opportunity of many members to meet Colonel Wall.

The next feature on the program was a showing by Mr. Vernon Wells, of the Carborundum Co. of America, Niagara Falls, N. Y., of the industrial films of that company having to do with the manufacture and use of abrasive materials. Mr. Wells gave a very interesting sketch of the history of the use of abrasives and injected into his talk a great deal of humor.

Major A. B. Quinton, Ord. Dept., U. S. A., of Aberdeen Proving Ground, who was a guest of the Post, described recent automotive development of the Ordnance Department.

Major William P. Wilson, Ord. Dept., U. S. A., of Frankford Arsenal, told about the antiaircraft fire-control instruments which he developed. As has been announced, Major Wilson died suddenly November 29, 1927.

Captain Hiram B. Ely, Ord. Dept., U. S. A., of Frankford Arsenal, gave a short résumé of his development of the sound locator, which gave all a further insight into the way in which nature's natural reactions can be harnessed for use.

This meeting was considered an unqualified success by all present and the hope was expressed that the future meetings of the Post would be attended by those members who have not, as yet, discovered the value that lies in attendance.

First Annual Meeting, St. Louis Post, A. O. A.

THE first annual meeting of the St. Louis Post, Army Ordnance Association, was held at the Jefferson Hotel, Tuesday evening, January 17, 1928. Col. Harry Scullin, Ord. Res., U. S. A., President of the Post, presided, and Maj. Gen. C. C. Williams, Chief of Ordnance, U. S. A., was the honor guest.

Following dinner at which approximately 100 were in attendance, the first business before the meeting was the election of officers for the coming year. Colonel Scullin, President of the Scullin Steel Company of St. Louis, and Col. E. D. Campbell, Ord. Res., U. S. A., of the American Car and Foundry Company, were reelected President and Vice-President respectively. The following directors of the Post, whose terms expired, were reelected for another term of two years: J. M. Kurn, President, St. Louis-San Francisco R. R. Co.; J. M. Olin, Vice-President, Western

Cartridge Company; J. W. Jarboe, President, Columbia Box Company; and E. D. Nims, President, Southwestern Bell Telephone Company.

General Williams, the principal speaker of the evening, gave a very entertaining talk on recent developments of the Ordnance Department. He stressed the importance of the St. Louis District in the industrial war plans of the Department and thanked Mr. Singleton, the St. Louis District Chief, and his assistants for the excellent work they have performed for the St. Louis District. He also expressed keen appreciation of the Department of the work of the St. Louis Post.

Following General Williams' address moving pictures of the Ninth Annual Meeting of the Army Ordnance Association at Aberdeen Proving Ground last October were shown. The reels depicted the principal events on the program and showed in excellent detail the remarkable strides made by the Ordnance Department in the development of antiaircraft artillery and the excellent results obtained by the Coast Artillery Corps in the firing of this equipment.

Annual Meeting of Cincinnati Post, A. O. A.

THE Cincinnati Post of the Army Ordnance Association held its annual meeting on January 26, 1928, at the Cincinnati Club, Cincinnati, Ohio. The meeting took the form of a dinner at which Maj. L. H. Campbell, Ord. Dept., U. S. A., of the Office of the Chief of Ordnance, was a guest. Officers of the Cincinnati Section, A. S. M. E., joined the Ordnance folks at the dinner and the result was a highly successful affair.

After dinner the following officers were inaugurated: President, Casper H. Rowe, Vice-President, Lt. Col. H. W. T. Collins, Ord. Res. Director to represent Cincinnati Post in the National Army Ordnance Association, Mr. Rowe; Directors: Mr. George Puchta; Major R. S. Barr, Ord. Dept., U. S. A.; Charles Hake, Jr.; Major A. L. Jenkins, Ord. Res.; James Monroe.

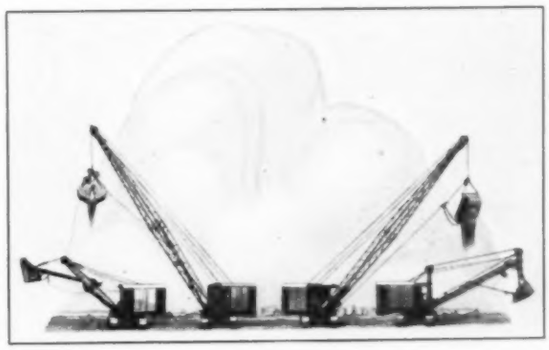
The meeting then adjourned to the rooms of the Engineers' Club nearby, where the local organizations of the A. S. M. E. and the A. O. A. met jointly. Major L. H. Campbell addressed the joint session on the subject, "Army Automotive Equipment." The lecture, illustrated by slides, was presented in fine style and showed in striking fashion the improvements effected since the war in automotive matériel. The lecture was attended by Col. W. H. Waldron and a number of his officers from Fort Thomas, an infantry post just across the Ohio from Cincinnati. A number of reserve officers of various branches also attended.

After the lecture two moving picture films were shown. The first was of the Ordnance Association Day Activities at Aberdeen Proving Ground last October. The second showed firings of latest antiaircraft artillery.

Cincinnati Post regards this meeting as the most successful and interesting gathering it has had to date.

Colonel Robbins, Assistant Secretary of War, Attends Pittsburgh Post Meeting

THE Assistant Secretary of War, Col. C. B. Robbins, made his first official visit to the Pittsburgh District on Friday and Saturday, March 2nd and 3rd, 1928, accompanied by Col. Wm. P. Wooten, Commandant of the



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Now—WESTERN Marksman .22 Long Rifle cartridges with Non-Corrosive Priming and Lesmok powder are available with bullets that are coated with *Lubaloy* by a new process. The greater accuracy, longer barrel life and non-fouling qualities which have made high power *Lubaloy* Sporting Cartridges so popular among riflemen are now available to the small bore enthusiast.

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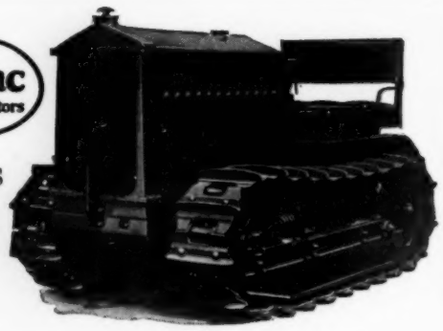

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Army Industrial College, who is also Director of Procurement.

Colonel Robbins and Colonel Wooten arrived in Pittsburgh early Friday morning and were met by Mr. R. M. Dravo, the District Chief, Mr. A. N. Diehl, Vice-President of the Carnegie Steel Company, and Captain Fred A. McMahon, the Executive Assistant. The party, after a breakfast as guests of Mr. Diehl, a close personal friend of Colonel Robbins, visited the Homestead plant of the Carnegie Steel Company.

At noon Mr. Dravo was host to Colonel Robbins and party at luncheon held in the Duquesne Club, at which in addition to Colonel Robbins, Colonel Wooten, Mr. Dravo and Captain McMahon the following were present: Norman Allderdice, President, Chromium Company of Pittsburgh; Taylor Allderdice, President, National Tube Company; Maj. Jarvis J. Bain, District Engineer; Frank B. Bell, President, Edgewater Steel Company; J. D. Berg, President, Dravo-Doyle Company; J. D. Callery, President, Diamond National Bank; Geo. S. Davison, President, Gulf Refining Company; A. N. Diehl, Vice-President, Carnegie Steel Company; T. P. Gaylord, Vice-President, Westinghouse Electric and Manufacturing Company; T. M. Girdler, President, Jones & Laughlin Steel Corp.; Henry Hornbostel; I. Lamont Hughes, Vice-President, Carnegie Steel Company; H. H. McClintic, Vice-President, McClintic-Marshall Company; C. D. Marshall, President, McClintic-Marshall Company; A. W. Robertson, President, Philadelphia Company; V. L. P. Shriver, Union National Bank of Pittsburgh, Director; John Slack, President, Union-Fidelity Title Insurance Company of Pittsburgh; E. T. Whiter, Vice-President, Pennsylvania Railroad Company; Homer D. Williams, President, Pittsburgh Steel Company.

In the afternoon the Assistant Secretary of War and Colonel Wooten inspected the activities of the Ordnance, Engineer and Chemical Warfare Procurement Offices.

On Saturday morning, March 3rd, at 10:00 o'clock, a very interesting and instructive meeting was held in Mr. Dravo's office, at which the following were present: Colonel Robbins; Brig. Gen. C. L'H. Ruggles, Assistant to the Chief of Ordnance; Colonel Wooten; Maj. P. J. O'Shaughnessy, Office of Chief of Ordnance; Mr. Dravo; Mr. J. C. Jones, District Chief, Philadelphia Ordnance District; Mr. B. C. Moise, Vice-President, National Tube Company; Lt. Col. Wm. M. Hogg, Assistant to Vice-President, National Tube Co.; Mr. J. J. Campbell, Vice-President, Carnegie Steel Company; Mr. Walter H. Dupka, Controller, Jones & Laughlin Steel Corp.; Lt. Col. H. A. Gidney, Comptroller, Gulf Oil Corp. of Pennsylvania; Mr. A. W. Bass, Assistant to Vice-President, Westinghouse E. & M. Co.; Major P. R. Faymonville, Executive Assistant, New York Ordnance District; Captain F. C. Shaffer, Executive Assistant, Philadelphia Ordnance District; Captain John K. Christmas, Ordnance Department; Captain Fred A. McMahon, Ordnance Department.

On Saturday evening at 6:30 the annual meeting and dinner of the Pittsburgh Post, Army Ordnance Association, was held at the Duquesne Club, at which the following were honor guests: Colonel Robbins; Brig. Gen. C. L'H. Ruggles, Ord. Dept., U. S. A.; Colonel Wooten; and Mr. J. C. Jones.

Mr. Allderdice introduced Colonel Robbins, who gave a very interesting address on Industrial Preparedness, and stated he was greatly delighted to see the interest that was being taken by industrialists in the program for national defense.

General Ruggles discussed the ordnance phase of the industrial preparedness program. General Ruggles took occasion to thank all for the interest which they are taking in the problem of National Defense and called attention to the fact that some of the members present had come from as far as 150 miles to show their interest in the cause.

Colonel Wooten gave a brief but interesting talk on the Mississippi Flood Control.

Pictures of the Ninth Annual Meeting of the Army Ordnance Association were then shown.

This was the largest and most interesting meeting held in Pittsburgh in behalf of National Defense. The number present was approximately 150.

Buffalo District and Watervliet Arsenal Ordnance Meetings

ON December 16, 1927, the Buffalo Ordnance District and the Watervliet Arsenal held the fourth semiannual meeting of reserve officers assigned to these organizations. These semiannual meetings were started two years ago to meet a condition prevailing in this particular locality. Ordnance Reserve officers assigned to the district and to the arsenal are scattered over a rather extensive territory. A limited number live within a 20 mile radius of headquarters and in this radius are also a few Ordnance officers assigned to other districts, maintenance companies, etc. There are not enough assigned to any one unit to make regular monthly meetings a success.

It was felt that Ordnance officers should have some opportunity to get together occasionally where they could feel it was their own party and Ordnance was the predominating idea. It was decided to ask the Reserve officers of other branches as guests and, in order to further acquaintance of all components with each other, to include National Guard officers. The programs were to be instructive but not too technical, and of a general enough nature to interest officers of all branches.

The first meeting was held in May, 1926, when Reserve officers were on active duty at Watervliet Arsenal. This was a nucleus to start on at least. The assistance of every unit headquarters in Troy, Albany and Schenectady was secured in giving publicity to the meeting. The Watervliet Arsenal shops were open for inspection during the afternoon to Reserve officers and their friends. Arsenal officers on duty conducted parties through and a shrinkage operation of an eight-inch Navy Gun was held at a previously announced time. This proved quite an attraction and such an operation has been planned for the afternoon of the day of each succeeding meeting. The meeting was held at 8 P. M. in the Assembly Hall, Headquarters Building, Watervliet Arsenal. Major G. M. Barnes gave an illustrated talk on "Experimental and Development Work of the Ordnance Department." The slides used showed on one-half the world war weapon and on the other half the latest type of the same weapon. This together with the information as to each type given by Major Barnes seemed to be of as much interest to line

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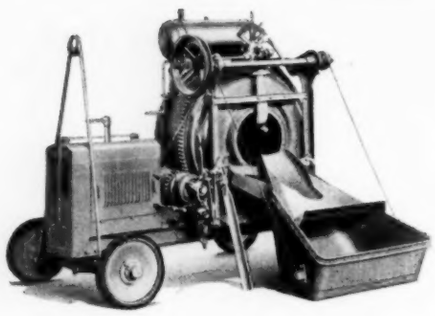

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officers as to Ordnance officers. This talk was followed by moving pictures of Ordnance Repair Shops, 14- and 16-inch Guns, and A.A. Gun test. Light refreshments were served and a general get-together lasted about an hour before the meeting broke up.

The attendance was 85 with officers from practically all branches of the Reserve and from local units of the National Guard. While the Reserve officers on active duty and the Regular officers formed a nucleus, it was felt that sufficient interest had been aroused to warrant the continuance of these meetings, providing they were not too frequent and providing the programs were kept rather general.

The second meeting was held in November, 1926, and without any Reserve officers on active duty as a nucleus the attendance rose to 100. Capt. John B. Fidlar, Ord. Dept., U. S. A., gave a talk on "The Lake Denmark Explosion." The rest of the program for this and succeeding meetings was similar to that of the first one. At the third meeting the principal feature was "Tanks, Tractors and Trailers," by Maj. L. H. Campbell, Ord. Dept., U. S. A., and at the fourth and last—"Latest Developments in Aircraft by the Army Air Corps," by Maj. R. P. Cousins, A. C., U. S. A.

The attendance of 110 indicates that these meetings can be continued to the mutual advantage of the Reserve, National Guard, and Regular Army in this vicinity. Holding them on a Regular Army Post seems to add to their prestige over meetings held in an office in town. The officers seem to feel that they are attending a military function as well as a get-together party. They are also taking more interest in making the meetings their own by offering suggestions and asking that certain additions be made to the program. It is hoped that this interest will grow until our Ordnance Reserve officers feel that these meetings are their own contribution to reserve activities in this section.

Recently Appointed Ordnance Reserve Officers

THE following Reserve officers have accepted commissions since the last issue of ARMY ORDNANCE:

Lieut. Col. Joshua B. Dickson, West end of West St., Petaluma, Calif.

Major Lindley W. Camp, 500 Cherokee St., Marietta, Ga.

Major Hilario A. Delgado, Capitol Bldg., Santa Fe, N. Mex.

Capt. Stanhope A. Ligon, Ft. Mill, S. C.

Capt. Frank Short, Box 417, Poughkeepsie, N. Y.

1st Lt. Carl F. Haussler, 109 Waterman Ave., Cranston, R. I.

1st Lt. Thomas J. Imler, 138 W. Merrill, Phoenix, Ariz.

1st Lt. Carl W. Laumann, c/o Bucyrus-Erie Co., So. Milwaukee, Wis.

2nd Lt. Herbert L. Bartholomew, 2612 Durant Ave., Apt. 7, Berkeley, Calif.

2nd Lt. Glenn H. Berry, 2631 W. Ave. 32, Los Angeles, Calif.

2nd Lt. Elmer W. Blau, 385 Oak St., San Francisco, Calif.

2nd Lt. Edgar Brooker, Kodiak, Alaska.

2nd Lt. John S. Camp, 937 So. 19th St., Birmingham, Ala.

2nd Lt. Francis O. Chase, 80 Federal St., Boston, Mass.

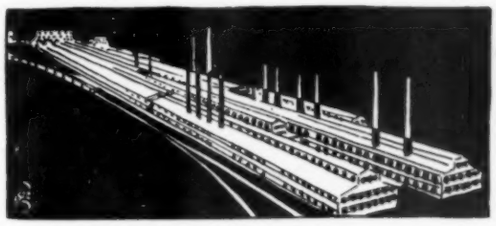
2nd Lt. Herbert G. Curtis, 711 Ravine Ave., Peoria, Ill.

2nd Lt. Bernard R. Davidson, 16 Elliott St., New Haven, Conn.
2nd Lt. Thomas A. Downey, Fort Preble, Maine.
2nd Lt. Basil W. Gaugler, 515 E. 27th St., Erie, Pa.
2nd Lt. Fridolph W. Hallgren, 702 Ash Ave., Ames, Iowa.
2nd Lt. Lloyd R. Hennig, 621 3rd Ave., San Francisco, Calif.
2nd Lt. Henry A. Huckaba, 943 Oliver Bldg., Pittsburgh, Pa.
2nd Lt. Chester E. Johnson, 1733 Broadway, New York, N. Y.
2nd Lt. John O. Johnson, 1909 America Ave., St. Louis, Mo.
2nd Lt. Theodore A. L. Loretz, 5658 Sunset Blvd., Los Angeles, Calif.
2nd Lt. George H. Lorimer, 37 Grant St., Chicopee, Mass
2nd Lt. Wayne C. Lyons, 238 21st Ave., San Francisco, Calif.
2nd Lt. Callahan J. McCarthy, 1213 Madison Ave., So. Milwaukee, Wis.
2nd Lt. Lauriston C. Marshall, 2 Le Conte Hall, University of California, Berkeley, Calif.
2nd Lt. Charles T. Michener, 4528 Regent St., Philadelphia, Pa.
2nd Lt. Hector A. Moineau, 73 Mt. Pleasant St., Marlboro, Mass.
2nd Lt. Tom O. Moore, 11th Ord. Co., Schofield Barracks, T. H.
2nd Lt. Eugene H. Oakley, 2610 Durant Ave., Berkeley, Calif.
2nd Lt. Harold A. Olsen, 2425 Grant St., Berkeley, Calif.
2nd Lt. James W. Percy, 527 Wells St., N. W., Canton, Ohio.
2nd Lt. Carl A. Poppino, Y. M. C. A., Schenectady, N. Y.
2nd Lt. Thomas E. Ridge, Box 167, Frenchtown, N. J.
2nd Lt. Charles T. Schulz, 201 Woodlawn Ave., Pittsfield, Mass.
2nd Lt. Kenneth M. Stott, 1324 Oxford St., Berkeley, Calif.
2nd Lt. James A. Taylor, 232 Kenyon St., Hartford, Conn.
2nd Lt. Frank E. Tepper, 406 Morton Ave., Ridley Park, Pa.
2nd Lt. Ralph W. Thornalley, 832 Paramount Road, Oakland, Calif.
2nd Lt. Edwin F. Trevor, 1227 Division St., Key West, Fla.
2nd Lt. James W. Walker, 2610 Durant Ave., Berkeley, Calif.
2nd Lt. John M. Wallace, 2123 Luray Ave., Cincinnati, Ohio.
2nd Lt. Ritchie R. Ward, 2607½ Ellsworth, Berkeley, Calif.
2nd Lt. Harold A. Wollenberg, 2425 College Ave., Berkeley, Calif.
2nd Lt. James A. Wood, 938 Hurt Bldg., Atlanta, Ga.
2nd Lt. Fenton R. Young, 1112 Broadbridge Ave., Stratford, Conn.

Ordnance Reserve Officers Recently Reappointed

THE following Reserve officers have accepted reappointment since the last issue of ARMY ORDNANCE:

Col. Thomas Denny, 32 E. 62nd St., New York, N. Y.



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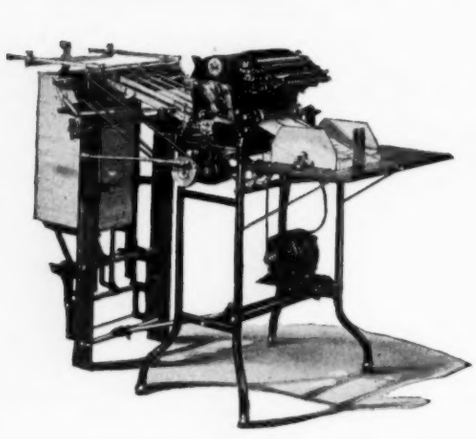

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Lt. Col. George S. Brady, 223 Halstead Ave., Mamaroneck, N. Y.
Lt. Col. Robert L. Messimer, 32 Lakeview Rd., Grosse Pointe Farms, Mich.
Lt. Col. George W. Steele, 603 W. 111th St., New York, N. Y.
Major Ernest M. Groos, Elizabeth Road, Terrell Hills, San Antonio, Tex.
Major Paul S. Hamilton, 11687 Griggs Blvd., Detroit, Mich.
Major Harry Hoisington, 1036 Oneida Ave., Davenport, Iowa.
Major Henry A. McCartney, Savanna Ord. Res. Depot, Savanna, Ill.
Major James T. Moody, 955 Ridgewood Drive, Highland Park, Ill.
Major Chester D. Richmond, 846 McCallie Ave., Chattanooga, Tenn.
Major George K. Saurwein, c/o Semet-Solvay Co., 40 Rector St., New York, N. Y.
Major Montgomery Schuyler, 6 Wall St., New York, N. Y.
Major Gerald E. Tenney, 86 Converse St., Longmeadow, Mass.
Major Fay B. Williams, Greenwood Terrace, Jenkintown, Pa.
Capt. Robert D. Bardwell, 120 Crofut St., Pittsfield, Mass.
Capt. George F. Comstock, Fort Lawton, Wash.
Capt. John N. Dix, 377 Philip Ave., Detroit, Mich.
Capt. Harold S. Eroe, General Delivery, Wharton, N. J.
Capt. Joseph E. Moorhead, Box 960, Denver, Colo.
Capt. Howard H. Payne, 103 Summit St., Pawtucket, R. I.
Capt. Samuel M. Regar, 105 W. Amelia Ave., Tampa, Fla.
Capt. Alfred A. Roberg, Auburn Court Apt., Mt. Auburn, Cincinnati, Ohio.
Capt. William E. Robinson, 2245 Pasadena Ave., Long Beach, Calif.
Capt. Francis R. Scherer, 534 Genesee St., Rochester, N. Y.
Capt. Wm. B. Williams, 1315 Spruce St., Philadelphia, Pa.
1st Lt. Alfred G. Asheroft, 515 Dawson Ave., Bellevue, Pa.
1st Lt. Myron L. Begeman, 110 Ferry St., St. Louis, Mo.
1st Lt. Carroll D. Billmyer, 842½ Cumberland St., Allentown, Pa.
1st Lt. Adolph P. Buquor, 1137 N. Orange Grove Ave., Hollywood, Calif.
1st Lt. Mark M. Conklin, 901 Broadway Exchange Bldg., Detroit, Mich.
1st Lt. Victor Fabian, 4734 N. Talman Ave., Chicago, Ill.
1st Lt. George L. Hunt, 223 No. 4th St., Atchison, Kans.
1st Lt. Thomas E. James, R. D. No. 2, Box 123A, Wharton, N. J.
1st Lt. Walter H. Montgomery, 100 Central Ave., Lewistown, Pa.
1st Lt. Roger W. Nevins, 54 Ellington St., Longmeadow, Mass.
1st Lt. Louis J. Reed, 123 Orchard St., Woodlawn, Pa.
1st Lt. Douglas L. Rehlaender, Ann & George Sts., Dover, N. J.
1st Lt. Prosper Russo, 215 5th Ave., McKeesport, Pa.
1st Lt. William W. Tinsley, Florahome, Fla.

2nd Lt. Saul J. Copellman, 145 Sutherland Rd., Brighton, Mass.
2nd Lt. F. F. Lange, 49 Barber Ave., Worcester, Mass.
2nd Lt. George H. Leavitt, 5908 Central Ave., Tampa, Fla.
2nd Lt. Allen M. Lindsley, 5810 Marshall St., Philadelphia, Pa.
2nd Lt. Campbell R. McCullough, 410 Memorial Drive, Cambridge, Mass.
2nd Lt. Robert A. Muller, 2936 Observatory Ave., Cincinnati, Ohio.
2nd Lt. George D. Stuart, 500 E. North Ave., Tarentum, Pa.
1st Lieut. William A. W. Von Gehr, 305 N. Meramec St., Clayton, Mo.

Commissioned in Specialist Reserve for Duty with Ordnance Department

RESERVE officers who are in the Specialist Reserve and have been assigned for duty with the Ordnance Department in connection with industrial procurement, in case of an emergency are:

Lieut. Col. Joseph A. Steinmetz, 1421 Chestnut St., Morris Bldg., Philadelphia, Pa.
Major Paul W. Bidwell, 16 Lexington Ave., Holyoke, Mass.
Major Harold M. Brayton, Picatinny Arsenal, Dover, N. J.
Major Welton J. Crook, 9 San Juan St., Stanford University, Calif.
Major John W. Hession, 155 Edgards Lane, Hastings-on-Hudson, N. Y.
Major Thomas A. Morgan, 147 Kilburn Road, Garden City, N. Y.
Major Andrew M. Platoff, 171 Jay St., Schenectady, N. Y.
Major Calvin W. Rice, 241 North Mountain Ave., Upper Montclair, N. J.
Major George R. Rupp, 1201 Calumet Ave., Calumet, Mich.
Major Hardie B. Walmsley, 247 Orange Rd., Montclair, N. J.
Capt. Oscar E. Abrams, 126 Harvard St., Springfield, Mass.
Capt. Gerald R. Brophy, 1318 Myron St., Schenectady, N. Y.
Capt. Lloyd M. Church, 64 Westland Ave., West Hartford, Conn.
Capt. Charles S. Comeaux, 103 Park Ave., New York, N. Y.
Capt. George E. Deethardt, 550 Broadmoor Blvd., San Leandro, Calif.
Capt. William A. Dower, 70 Homestead Ave., Hartford, Conn.
Capt. Robert J. Johnson, 34 Schley Ave., Ingram, Crafton, P. O., Pa.
Capt. H. E. Norman, 787 Armory St., Springfield, Mass.
Capt. Harold E. Schofield, 532 Righter St., Wissahickon, Philadelphia, Pa.
Capt. Otto R. Schurig, 1011 Eastern Ave., Schenectady, N. Y.
Capt. J. C. Solberg, 255 Massachusetts Ave., Arlington, Mass.
Capt. Richard Stanton, 217 Hillside Ave., Hartford, Conn.
Capt. S. B. Terry, 242 Wolcott Hill, Wethersfield, Conn.
Capt. John A. Willners, 4733 Frankford Ave., Philadelphia, Pa.
Capt. Arthur G. Woerz, 1185 Farmington Ave., West Hartford, Conn.

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Aircraft Department

BUFFALO, N. Y.

Patents

Brief Descriptions of Inventions of Interest to Ordnance Engineers

Compiled by W. N. Roach, Chief, Patent Section, Office of the Chief of Ordnance

THE patents of recent issue relating particularly to ammunition include:

John S. Barker, formerly of the Office of the Chief of Ordnance, assignor to Bethlehem Steel Company, has been granted patent No. 1,648,603, for a detonating fuze. The main object of this invention is the provision of a fuze which can be selectively set for quick action or delay action. Two firing pins are provided, the quick action firing pin being provided with means for locking the same against action when delay action is desired.

Capt. Charles H. Keck, Ord. Dept., U. S. A., has been granted patent No. 1,649,784, for a propellant powder containing nitrocellulose and dinitrobenzol.

Captain Keck has been granted patent No. 1,651,459 for a propellant powder. This patent covers an explosive containing nitrocellulose and a nitrated vegetable oil.

Patent No. 1,650,186 has been granted to Hubert H. Champney, assignor to Hercules Powder Company, for an explosive which contains an explosive ingredient, a sensitizer and ground oat hulls, the use of the latter constituting the novelty.

Patent No. 1,650,300 has been granted to Leon E. Remondy, for a percussion fuze for projectiles, aërial bombs, and the like. This fuze consists of firing elements, one of which, preferably the firing pin, is movable, and more particularly adapted to be engaged by a striker to impart a blow to the firing pin causing the same to move into contact with the primer.

Patent No. 1,651,696 has been granted to Nevil Greenwell, assignor to Bethlehem Steel Company, for a detonating fuze. The patent concerns a specific means for maintaining the detonator and booster normally separate and for causing the detonator to enter a cavity in the booster chamber when the projectile strikes the target.

Bohdan Pantoflicek has been granted patent No. 1,652,635, for a percussion fuze. This invention contemplates the provision of a light striker or firing pin normally mounted in a light diaphragm or disk, the purpose being to provide a sensitive fuze.

Maj. Harold M. Brayton, Spec. Res., U. S. A., of Picatinny Arsenal, has been granted patent No. 1,655,591, for a combination fuze. This patent contemplates specific means for normally locking a quick action firing pin against movement.

Patent No. 1,655,653 has been granted to John Kowolchuk, for a safety shell. This patent covers a specific form of safety clip attached to the outer surface of the nose of a shell and surrounding the extruding head of the plunger or firing pin to hold the same in unarmed position.

Patent No. 1,656,361, granted to Harry J. Nichols for a projectile, has as its main object the provision of a specific form of base plug for an armor-piercing projectile which will enable the shell to withstand side stresses.

MAJOR Keith F. Adamson, Ord. Dept., U. S. A., Office of the Chief of Ordnance, and Henry J. Stambaugh, Aberdeen Proving Ground, have been granted patent No. 1,648,469, for an automatic gun. The invention relates to a gun, preferably the 37-mm., an automatic gun of the sliding breech block type, in which extraction takes place during an early stage of recoil and ejection during a latter stage. An automatic rammer is also provided which rams a cartridge directly from the magazine into the cartridge chamber while the gun is still in full recoil.

Edward M. Hewlett and Waldo W. Willard, assignors to General Electric Company, have been granted patent No. 1,650,626, for a system of gun fire control. In this system corrections are first applied to this sighting device and may then be introduced in the gun-directing apparatus by readjustment of the sight device, if necessary.

Capt. James C. Karnes, Ord. Res., U. S. A., Office of the Chief of Ordnance, has been granted patent No. 1,654,734, for a cartridge. The object of this invention is the provision of a cartridge the fuze of which may be set after insertion in the cartridge chamber of a gun.

Harry C. Zimmerman of the Office of the Chief of Ordnance has been granted patent No. 1,654,908, for a trail connection for gun carriages. The main object of this invention is the provision of a demountable trail for infantry accompanying guns forming a connection which may be speedily uncoupled and recoupled.

Arthur T. Dawson and George T. Buckham, assignors to Vickers, Ltd., have been granted patent No. 1,656,727, for an ammunition loading apparatus. This invention contemplates the provision of a screw-thread-operated rammer preferably operated through means of a motor.

Capt. Elmer C. Goebert, Ord. Dept., U. S. A., has been granted patent No. 1,657,009, for a gun mount. This invention contemplates the provision of a specific means for taking the weight of a carriage off the springs when firing and also providing special bearing for the carriage so that it may have angular movement with respect to the axle in both the traveling and firing positions.

Patent No. 1,658,005 has been granted to Nicolas E. Methlin, assignor to Schneider et Cie, for a "piece of ordnance, more particularly adapted for firing against aircraft," which has for its main object the provision of a gun so constructed as to be assembled readily with its carriage for transporting and disassembled when it is to be placed in firing position.

THE following patents relate more particularly to firearms.

Rudolf von Frommer has been granted patent No. 1,645,031, for a cartridge magazine. The main object of this invention is the provision of a large magazine which may be adjusted to deliver either all or a portion of the cartridges therein.

Eugene H. Strong has been granted patent No. 1,645,881, for an electric target practice apparatus for firearms. The main object of this invention is the provision of a cartridge-shaped electric bulb holder having a switch there-

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in adapted to make contact when the firing pin of the firearm is struck by the hammer.

Patent No. 1,646,699 has been granted to Crawford C. Loomis, assignor to Remington Arms Company, Inc., for a firearm. The main object of this invention is the provision of a buffer which will cushion the rear moving breech bolt of a firearm without accelerating its forward movement.

Patent No. 1,648,833 has been granted to Gustavo Vincon, for a breech-closing mechanism for automatic firearms. This invention contemplates the provision of a specific means for locking and unlocking the breech bolt of the arm.

Henry B. Inglis, McCook Field, Ohio, has been granted patent No. 1,650,628, for a gun sight, the main object of the invention being the provision of an adjustable sight for flexible guns mounted on airplanes.

Yves P. G. Leprieur, assignor to Societe Anonyme La Precision Moderne, has been granted patent No. 1,651,093 for a sight for machine guns for antiaircraft firing.

Capt. Thomas M. Jervey, Ord. Dept., U. S. A., Aberdeen Proving Ground, has been granted patent No. 1,651,128, for an automatic gun. This invention has as its main object the provision of an automatic gun having novel means for positioning a charge to be loaded together with a novel rammer for forcing the charge home. The operation of the positioning means is such that jamming is easily and quickly overcome.

Patent No. 1,656,786 has been granted to John Joseph Gahan, for a machine gun fire data finder. The main object of this invention is the provision of a comparatively simple device for obtaining necessary data, which may be easily and quickly operated.

Cesare Soncini, assignor to Societa Italiana Ernesto Breda, has been granted patent No. 1,656,960, for a device for lubricating automatic firearms. The invention contemplates the provision of a reservoir for containing lubricant with an adjustable valve regulating the flow of the lubricant.

The same inventor, assignor to Societa Italiana Ernesto Breda, also has been granted patent No. 1,656,961, for safety lock for automatic firearms. This invention contemplates the provision of a spring-actuated locking member which locks the firing pin against actuation until the breech bolt is completely closed.

Charles Sutter, assignor to Societe Anonyme Des Anciens Etablissements Hotchkiss & Compagnie, has been granted patent No. 1,656,845, for a combined loader ejector and safety mechanism for firearms.

Correction

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Books

Pistols and Revolvers and Their Use. By Maj. Julian S. Hatcher, Ord. Dept., U. S. A. Marshallton, Del.: Small Arms Technical Publishing Co. 1927. $3.75.

VIRGIN soil is broken in this timely volume more often than the average gun lover would think possible in a book of its scope. At last some of the fallacies of those who argue for the abolition of the pistol are discussed—freely but without rancor, a tribute to the fairmindedness of the author, who cannot but feel strongly on the subject, and in marked contrast to the hysterical shoutings of those whose false logic he exposes. Would that every legislator and police commissioner might be required to memorize, and repeat daily, certain paragraphs bearing upon this vital subject.

Again, instructions for dismounting and reassembling are included for every arm which is considered worthy of detailed description,—another innovation in a book of this character, and a boon to the amateur gunsmith. Many other simple but useful bits of information appear, such as those bearing upon the advisability of putting cotton in one's ears when firing heavy loads, and the fact that snapping the hammer of an empty gun is *not* injurious,—little suggestions in themselves, but of much practical value.

Probably the most interesting new feature is the extensive discussion of stopping power, or "shock power" tests, as made with various arms, and the publication of tables computed from a simple formula in which the sectional area of the bullet in square inches is multiplied by muzzle velocity, the product being taken as an index of "shock power." This is a subject which, despite its importance from the standpoint of shooting in self-defence, has heretofore received scant attention. The chapter on reloading treats the subject comprehensively enough to answer all the problems of the beginner, and gives references to works which will solve those of the more advanced reloader.

Two statements in this book require modification. The first appears on page 25 and is that the Webley-Fosbery "is the only instance of the application of the automatic principle to the revolver," whereas this principle is very completely embodied in the .32 caliber semi-automatic revolver lately manufactured by the Union Firearms Company, of Toledo, Ohio. The second, on page 145, describes .32 caliber Smith and Wesson arms as having six grooves. This holds for their automatic pistol, but not for their revolvers.

By way of summary, the book is delightfully easy in style, comprehensive in scope, presents more new, interesting, and important subject matter, and is better balanced and more readable than any volume in its field so far.

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volume, "Disraeli," he surpasses his previous achievements with a masterpiece of biographical writing, the enthusiastic reception of which in France and England will unquestionably be paralleled in this country. Maurois understands and loves his subject and all his idiosynerasies. He draws a sympathetic portrait of the man and his immense struggles to reach the goal of his early dreams through years of disappointment. On the other hand, Maurois fails to understand Gladstone, and the one defect of the book is his unsympathetic characterization of Disraeli's political rival. A man with such essential variations from the English character as Disraeli seems strangely out of place in his Victorian environment and the fact of his ultimate success seems all the more astounding. The charm of the author's style has lost nothing in this excellent translation.

Bismarck, the Story of a Fighter. By Emil Ludwig. Boston: Little, Brown & Co. $5.00.

MOST biographers paint the subject of their work in glowing colors. Ludwig's characteristic mode is to portray the good with the bad and leave judgment to the reader.

Bismarck's youth is dealt with at considerable length on the basis that he had to endure the most violent agitations during the first thirty years of his life and all that followed throughout his career was no more than a deepening of the elementary lines already traced.

The Iron Chancellor who for a decade held the fate of Europe in his hand is presented as a gloomy figure whose life was a perpetual struggle. His foreign policy is presented as a learned one while his policy at home is that of a typical Junker and may be summed in the quotation from von Bunsen, "Bismarck makes Germany great and the Germans small." Toward the end of his life after he has been relieved as chancellor he appreciates the qualities of his countrymen.

Bismarck foresaw that any misunderstanding with Russia would throw her into the arms of France and struggled for an understanding with Russia during the last of his years as chancellor. Failure to renew an existing treaty in 1890 was due to Kaiser Wilhelm II.

The value of his foreign policies are more apparent now than during his régime. He was the master diplomatist of Europe. His forecasts of the fall of the German monarchy and the founding of the Republic were realized. He foresaw the overthrow of the Russian Czars and the condition the country would be in. His attempts at a rapproachment with England were unavailing.

While we are impressed with the able presentation of the subject we lay the book down with a feeling that it is not as delightfully written as "Napoleon" by the same author.

John Paul Jones: Man of Action. By Phillips Russell. New York: Brentano's. 1927. $5.00.

TO understand better the character of our foremost American naval hero, one should read this new book by Phillips Russell. He depicts for us Jones' unquestioned genius as well as the many qualities and characteristics which went to make up the real man.

It is true that Jones was frequently bitterly disappointed both in the commissions given him and in the lack of opportunity offered of bringing his superior talents into play. He was also grieved at the failure of the American Con-

gress, the French Government and the Russian Empire to acknowledge his services and abilities. He often reached for the unattainable—perhaps due to the strange mixture in his nature of adventurer, bold seaman, poet, lover of "poetic ease" and of the finer niceties of life.

The book clearly shows Jones as a marvelous independent commander, inspiring his men by his personal courage and coolness in action. It does not appear that he was so able as a director of several units where the influence of his personality could not be felt.

Mr. Russell has given much detail concerning the variety and susceptibility to flattery of this daring commander. His many love affairs and his service in the navy of Catherine II of Russia comprise many chapters.

The Next Age of Man. By Albert Edward Wiggam. Indianapolis: The Bobbs Merrill Company. 1927. $3.00.

IS the decline of civilization as inevitable as some recent writers would have us believe, or can the far greater knowledge we have of heredity suggest a remedy to avoid the same conditions that brought about the fall of other civilizations? The popularization of the scientific findings of the great biologists in the matter of heredity has once more been successfully attempted by Mr. Wiggam in this book which cannot fail to cause the reader to reflect on the great possibilities of the application of this new knowledge. Written in a most entertaining and lucid style, the author shows to how great an extent society can consciously control its own future and avoid the great dangers that threaten its very existence.

The Nature of Matter, Gravitation, and Light. By Albert P. Mathews, Ph. D. New York: William Wood & Co. 1927. $3.50.

THE author, in the preface, explains that he, a biochemist and biologist by profession, while seeking the explanation of certain phenomena pertaining to his chosen field of investigation which concerns living matter, delved into the results obtained by physicists bearing on such subjects as cohesion and surface tension. He finds that these subjects have been greatly neglected and in this volume expounds his conception of the nature of matter, gravitation, light and other pertinent phenomena.

This book cannot be reviewed in a few words owing to the profundity of the theories advanced and the classic way in which they are expounded. Dr. Mathews views all matter and physical phenomena as different manifestations of the neutral electron—the etherial unit or vortex, which he calls an "etherion" and visualizes it as a spherical entity rotating simultaneously about its three axes and moving transversely with respect to time. He further maintains that matter, electricity and light are but modifications of this four dimensional solid-fluid continuum of space-time. New units such as the "lodges," newtons," "peses," "kines," and "helectrons" are suggested and defined.

His handling of dimensional analysis and his new theory of light being propagated in rays is very stimulating to the mind and his contention that ether in motion accounts very simply for mechanical, electrical, magnetic, and physical phenomena should produce far-reaching thought and developments. This book is clearly and convincingly writ-

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ten on a subject concerning which little is known conclusively and should be welcomed by scientists in all fields of investigation who look forward to the day when the author will be able to prove that radiant energy can be changed into matter in the way he visualizes.

Economics and Human Behavior. By P. Sargant Florence, Ph. D. New York: W. W. Norton & Co., Inc. 1927. $1.00.

THIS monograph, which can be read in an evening, is one of the New Science Series edited by C. K. Ogden. Although the series is published for "popular" reading each author is, as in this case, a specialist in his subject. The book under review takes the intelligent view that man is a complex animal acting from a number of variously compounded motives and emotions.

Doctor Florence advocates a compromise between the classic economists and the modern psychologists; he shows convincingly that much of human behavior in the market place is based on the emotions rather than on economic laws (as advertising men have long known). It is a good book in a much-needed field, that of co-relating the various special sciences with respect to man and life as a whole.

Bridle Wise. A Key to Better Hunters, Better Ponies. By Lt. Col. S. G. Goldschmidt. New York: Charles Scribner's Sons. 1927. $5.00.

OUT of an experience of thirty years in the breaking and schooling of horses, the author has produced what is obviously a labor of love in this new contribution to the literature on equitation. Colonel Goldschmidt's theory is that a rider should also be a horse-breaker. His early chapter on the psychology of the horse is most useful in emphasizing the instincts to be considered in training.

Teaching the horse to obey the aids is followed by details on the successive steps in breaking the hunter and the polo pony. There is much information for the rider in this book no matter how much experience he may have had, and it is presented in a most attractive fashion.

A. S. T. M. Tentative Standards, 1927. Philadelphia: American Society for Testing Materials. 1927. $7.00.

THE Tentative Standards of the A. S. T. M. comprise those specifications which are printed for one or more years for the purpose of eliciting criticism of which the committee of the Society concerned will take due cognizance before recommending final action toward the adoption of such tentative standards by formal action of the Society.

The 1927 edition of A. S. T. M. Tentative Standards contains provisional specifications for the following materials: 18 relating to ferrous metals; 20 non-ferrous metals; 26 cement, lime gypsum and clay products; 31 preservative coatings and petroleum products; 39 road materials; 3 waterproofing and roofing materials; 21 rubber products, insulating and textile materials; 17 coal, coke, timber and miscellaneous materials.

As in previous editions of this work, the 1927 edition shows the same careful and comprehensive study. The Society, through its various committees and executive offices, is performing a very valuable service for all branches of American industry.

American Policy in Nicaragua. By Henry L. Stimson, M. A., L. L. D. New York: Charles Scribner's Sons. 1927. $1.25.

THE press of the world has offered to its readers a mass of conflicting, exaggerated and erroneous accounts of the policy and actions of the United States in our relation to our sister Republic of Nicaragua. Our Department of State has been censored by word and picture most caustiely for playing the part of a bully and tyrant in its diplomatic relations with her. The author, because of his broad view-point obtained while Secretary of War and because of his first hand knowledge secured as personal representative to Nicaragua in 1927 for President Coolidge is eminently fitted to state what our policy has been with regard to that Nation and what its effect has been, and more particularly is he qualified to state the conditions surrounding the happenings of the past year. This he has done in a clear and condensed style which presents the whole situation most comprehensively, an understanding of which is necessary for every well informed American.

Mr. Stimson is responsible for the stopping of the last Nicaraguan revolution and for the present agreement that the United States will assist in the supervision of the National election of 1928, for which purpose General Frank R. McCoy has been nominated by the President for the position of chairman of the National Board of Elections and accepted by Nicaragua.

The polities of that country and the need for unbiased assistance toward internal harmony are made clear. This book answers for all time those who are too prone to make thoughtless and baseless criticisms of our present Nicaraguan or other Central American policy.

How to Read a Profit and Loss Statement. By Herbert S. Stockwell. New York: The Ronald Press Company. 1927. $4.50.

PROFIT and loss statements, which too often seem hopelessly involved to the layman without training in accounting methods, are clearly and amply explained in this excellent volume by a well qualified authority on the subject. Mr. Stockwell first presents an outline of the essentials of nearly all profit and loss accounts and in subsequent chapters considers each item in considerable detail.

Additional chapters such as those on the method of analyzing these statements and on the many forms of manipulation to conceal true conditions are of great value in making this book a most complete manual on the subject.

How to Read a Financial Statement. By Herbert S. Stockwell. New York: The Ronald Press Company. 1927. $4.50.

LARGE numbers of books have been written on the construction of financial statements, but there is a very limited literature available on the interpretation of such statements that may come into the hands of business men and investors. Consequently this book fills a long-felt want in providing, in a non-technical manner, the methods of analysis of statements which will accomplish the desired purpose of showing the true condition of a business.

The book is divided into two parts, the first devoted to the analysis of the simpler statements of the average sized business, while the second part deals with the more un-

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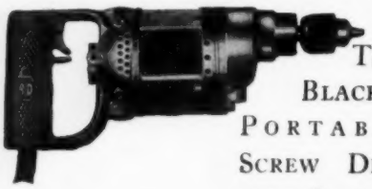

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usual features found especially in the statements of the larger corporations. It is a most thorough and satisfactory treatment of every phase of the balance sheet with numerous case illustrations well chosen to illustrate the various forms ordinarily encountered.

Gentleman Johnny Burgoyne. By F. J. Hudleston. Indianapolis: The Bobbs-Merrill Company. 1927. $5.00.

THE librarian of the British War Office has written a brilliant, entertaining and very scholarly biography of a man heretofore well but unfavorably known to most Americans. It is written in the modern realistic manner but is nevertheless always gay and balanced.

The author's amused and cultured detachment in discussing the controversial points in his hero's American campaigns inspires confidence in the whole work, which deals mainly with the period indicated by the sub-title, "Misadventures of an English General in the Revolution." An appendix on Burgoyne as a dramatist and a selected bibliography are included.

This is a biography of the highest quality and workmanship that holds the reader like a good novel. Let us hope Mr. Hudleston will write of other Englishmen who have appeared on the American scene.

The book is well printed; it is illustrated and indexed.

Your Money's Worth. By Stuart Chase and F. J. Schlink. New York: The MacMillan Co. 1927. $2.00.

WHO is there who is not interested in the family purse? The authors have given us a tremendous amount of information which they have been at great pains to collect and verify, illustrating the deception which can be and is practiced by the countless extensive advertising campaigns of today. The book is written in an amusing and interesting manner and is most readable from beginning to end.

There is much food for the thoughtful in it. The authors endeavor to lay before us the wonderland of intensive advertising and salesmanship and to show us a solution of the ever present problem of how to get an honest return for the money expended.

The first part of the book gives one concrete example after another of exaggerated advertising and "high powered" salesmanship, showing the maze in which the average buyer finds himself. The second part describes the existing laboratories where unbiased testing is being carried on and particularly the Bureau of Standards in Washington, D. C. The book is convincingly written and full of potential possibilities for the future if sufficient demand by the public can be created for scientific laboratories from which they can get accurate information as to the true character of goods on the market and so circumvent the present bewildering chaos of unsound advertising and ever increasing urge on the part of the salesman to buy regardless of value.

Psychology—What It Has to Teach You About Yourself and Your World. By Everett Dean Martin. New York: W. W. Norton & Co., Inc. 1927. $3.00.

THE original presentation of this Psychology was in the form of lectures for a non-technical audience, and to this fact is undoubtedly due in some measure the remarkable clearness and simplicity characteristic of the author's

style. The psychology of the individual is the subject of the first part of the book, while social psychology, with such problems as the question of the group mind, the psychology of propaganda and public opinion, of religion, of polities, etc., are discussed in the latter half. In a masterly summing up, Mr. Martin analyses the nature of progress and shows in what way psychology can come to the rescue of those factors in our present day culture that mark a decline. It is a very valuable and helpful book.

A. S. T. M. Standards, 1927. Philadelphia: American Society of Testing Materials. 1927. 2 Vols. $14.00.

THIS is the 1927 edition of the triennial Book of A. S. T. M. Standards. Volume 1 is devoted to metals and contains adopted standards for 147 metallic materials. Volume 2 contains standards for 196 non-metallic substances. The standards of the American Society for Testing Materials are recognized as authoritative in the field of engineering materials. The specifications described in these volumes indicate the excellent work being done by the Society and are recommended to all whose professional or business activities require standards of materials.

The Zeppelins. The Development of the Airship, with the Story of the Zeppelin Air Raids in the World War. By Captain Ernst A. Lehmann and Howard Mingos. New York: J. H. Sears & Company, Inc. 1927. $4.00.

IN the history of the Zeppelins from the pen of one of their pilots it might be feared that the defects of these ships would be minimized and their achievements magnified, but one gains the decided impression that the authors have written with great moderation and fairness. Captain Lehmann, a naval architect who associated himself with Count Zeppelin in 1913, and piloted these lighter-than-air ships throughout the war, has written with Mr. Mingos a thrilling narrative of the bombing attacks against England, France, the Balkans, etc., and of the scouting expeditions over the North Sea during the World War. The race between the offensive power of these air ships and the ground and air defenses against them is described most interestingly. As a presentation of the other side of the picture, this book is an excellent source of information concerning the powers and limitations of these craft.

Francis Joseph, Emperor of Austria—King of Hungary. By Eugene Bagger. New York: G. P. Putnam's Sons. 1927. $5.00.

TO have written an interesting biography of Francis Joseph of Austria, the rather mediocre and uninteresting emperor who ruled that heterogeneous empire from 1848 to his death in 1916, is Mr. Bagger's achievement in this book. The Hapsburg whose death antedated the final crumbling of the Holy Roman Empire by so little time, emerges as a colorless, amazingly cold being, whose sole passion was the chase, and who could apparently scarcely be touched by the many terrific tragedies that marked his long life, such as the murder of his wife, the suicide of his son, and the death at the hands of a firing squad of his brother Maximilian.

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meaning to the reader of this book, for the political events of the long reign are described in such a way as to leave a lasting impression. The emperor and his contemporaries are sketched in the vigorous and vivid style characteristic of the author.

Historic Railroads. By Rupert Sargent Holland. Illustrated by Manning de V. Lee. Philadelphia: Macrae, Smith Company. 1927.

IN this splendidly bound and printed volume, the revolution in transportation accomplished since the invention and development of the railroad is emphasized by the contrast with the facilities for moving passengers and freight available a century and a quarter ago. The difficulties of travel in pre-railroad days are cleverly told in the opening chapter by means of excerpts from writings of the period. The vast number of obstacles that had to be overcome to make the first English railroad a success were equally prevalent in our own country, and it is a magnificent achievement that the perfected systems we know today could have developed in the last hundred years in the face of tremendous odds. The histories of the great English and American roads are given in considerable detail and are well told. In succeeding chapters the most interesting railroads in all countries are described from the point of view of construction and routing. The artistic illustrations by Mr. Lee are a distinct contribution to the general

That Mind of Yours. By Daniel Bell Leary, Ph. D. Philadelphia: J. B. Lippincott Co. 1927. $1.75.

IN a compact and handy little volume Dr. Leary analyzes the principles of psychology for the man in the street who will have no difficulty in understanding the meaning of the author throughout.

The book is written with the express purpose of being useful to the individual and to society in providing a simple description of the workings of the human mind. The normal human being is first considered and a study of the abnormal is followed by a consideration of the wider applications of psychology to aesthetics and religion. It provides a readable introduction to the vast field of the new psychology.

Genghis Khan: The Emperor of All Men. By Harold Lamb. New York: Robert M. McBride & Co. 1927. $3.50.

GENGHIS KHAN is a dim figure in history to most of us; but after reading this intensely interesting and alive biography, he and his conquests will have a distinct place in our minds for all time. Seven hundred years ago he almost conquered the earth—he outgeneraled the best soldiers and warriors of three empires—he devised a code of laws for his own people and for those whom he conquered, and yet he knew nothing of cities and their government—in fact, he did not even know how to write. He was only a nomad, a hunter and herder of beasts by birth; before he died he was known not only as the "Mighty Manslayer" and the "Scourge of God," but also as the "Perfect Worker" and the "Master of Thrones and Crowns." Mr. Lamb is to be congratulated on being able to revivify so clearly and definitely this strange and dominant Asiatic character of the 13th Century.

Jacques Coeur, Merchant Prince of the Middle Ages. By Albert Boardman Kerr. New York: Charles Scribner's Sons. 1927. $3.50.

FIVE hundred years ago, a Frenchman born in the city of Bourges achieved the rare distinction in those days of rising from the level of the small merchant class to a position of wealth and power without equal in the realm. Ennobled by Charles VII, he was as instrumental as Jeanne d'Arc in reëstablishing the French monarchy and driving the English from his native land. Thousands of American soldiers passed through Bourges in the great war and, admiring the palace built by Jacques Coeur, had to content themselves with the most fragmentary information concerning the life and character of the great merchant prince. Mr. Kerr has met this want in this interesting biography which combines the astonishing story of Coeur's rise to power, his betrayal and flight, and an unusually good description of the economic and political forces of the times.

An American Soldier and Diplomat: Horace Porter. By Elsie Porter Mende, in collaboration with Henry Greenleaf Pearson. New York: Frederick A. Stokes Co. 1927. $5.00.

THIS is the biography of an American who was a Medal of Honor soldier, a successful business engineer, an author, public speaker and a much honored diplomat. General Horace Porter had important roles to play in times when keen judgment and discriminating tact were the requisites.

A graduate of West Point just previous to the Civil War, he displayed remarkable courage throughout the war and especially at Chickamauga. Well known to General Grant, he was on that officer's staff during the last years of the war and was also Grant's secretary when he was President. As an engineer in New York City he directed big enterprises. The most interesting part of his life is that period when he was ambassador to France, 1897-1905.

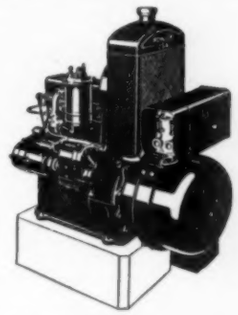
All this and more is told in this interesting book by his daughter, who accompanied her father to the Queen of Holland's wedding, to entertainments by the Czar of Russia, balls at the Russian and German Courts, a reception by the Sultan of Turkey, and who often acted as a hostess for him during these busy years, due to Mrs. Porter's delicate health.

It was Porter who unearthed the remains of John Paul Jones and by his untiring determination saw that a forgetful nation properly honored its great naval hero with a fitting monument in the crypt of the chapel at Annapolis—an inspiration to the youth who follow in his footsteps. To him also is due the credit for the erection of the beautiful tomb in New York to honor and perpetuate the memory of General Grant. His vast experience in diplomatic Europe made him the logical choice as the American delegate at the first Hague Conference.

Propaganda Technique in the World War. By Prof. Harold D. Laswell. New York: Alfred A. Knopf. 1927.

THE author shows that the main objectives of war propaganda are to mobilize hatred against the enemy; to preserve the friendship of allies; to preserve the friendship and, if possible, to procure the coöperation of neutrals; and to demoralize the enemy.

He shows that three typical organizations for this purpose were in operation during the World War. The United



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States adopted the system of a single propaganda executive; Great Britain used a committee of executives, each being responsible for a certain branch of propaganda work; while Germany arranged for a common press conference for all departments, but provided that all other forms of effort should be exerted by regular offices or departments affected. The degree of success attained by these various organizations is made apparent by concrete references to the experiences of the various countries involved.

It is axiomatic that propaganda can accomplish both good and evil and in a democratic government it is obvious that for the common welfare all possible chance of manipulation by political parties or other organizations should be made impossible.

A proper understanding of this subject is indispensable to the nation and this book, which briefly and clearly sets forth the issues involved, should be widely read both by soldiers and non-combatants; in effect by all interested in the perpetuation of international peace and harmony.

Small Bore Rifle Shooting. By Capt. Edward C. Crossman. Marshallton, Del.: Small Arms Technical Publishing Co. 1927.

IT is really astounding to discover how much there *is* to know about this type of ballistic diversion, and how much one man *does* know about it. Three hundred and thirty-seven pages on such a subject is a rather sizeable dose, and one which, in unskilled hands, could readily become a disagreeable one. But Crossman, as those familiar with his writings know, possesses the happy art of making his topic always interesting. And his present book is no exception.

After a short introduction to tell us just what small bore rifle shooting *is*, he proceeds to discuss rifles, ammunition, ballistics, targets and ranges, and the rifleman's equipment, each in a separate chapter, together occupying 192 pages. Having brought his tyro to the firing line duly armed and equipped, he does not now forsake him there, but leads him gently through the mazes of arranging equipment, adjusting sling, adopting position, sighting, trigger pull, etc. Other chapters concern the making of high scores, care of the rifle, the rifle team, the rifle club, shooting for women, etc. Each subject is discussed in such detail that he who possesses a copy of the volume has small excuse for not knowing almost all there is to know about small bore shooting.

The book is overflowing with valuable little hints, products of long personal experience, upon things not commonly known, which should tend greatly to smooth the pathway of the beginner. Conversely, fallacies are exposed and exploded when necessary. "There are a lot of well-known things about the rifle game which are not so," as Crossman expresses it.

By way of criticism, the Captain does like to split an infinitive occasionally, but this has become such a popular pastime that it is hardly subject to censure. The typographical errors are few, but one correction which should be made is the substitution of "spherical" for "cylinder" lens (page 175, next the last line) in the description of magnifying front sights.

Crossman, when aroused, wields such a wicked pen that it would be great sport to discover more faults in his book, —just to hear him sputter. Unfortunately, diligent search fails to reveal any!